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Hydraulic System.

It is the nervous System that particularly distinguishes Man & fits him for life & action. The Hydraulic is however necessary to his Existence, a most important part therefore, but not so much so as hath been formerly imagined.

This part seems to promise much and to be able to be reduced to some certainty, whether this has been done is to be considered. We shall divide our plan into four parts.

I. Vessels which contain the Blood.

II. Course of these Vessels.

III. Power by which the Blood is moved.

IV. General Laws & affections of the System so far as it is Hydraulic.

I. Vessels that contain the Blood, which are the Heart, Arteries, and Veins. Secretories shall be spoken of in another place.

1. The Heart is a hollow Muscle with two Cavities called Ventricles & two appendages called Auricles; it is attached to the Arteries & Veins, & each Ventricle communicates with an Artery

and

and one Vein only, at whose mouths are Valves which only suffer fluids to pass one way. These Cavities are each surrounded with a fleshy Mass separable into distinct fibres wch lie in very dif=ferent directions. This arrangement has been particularly studied, but as yet without much success. We can plainly see that they are Mus=cular fibres, & in consequence of this these cavi=ties are alternately dilated & contracted, & so far capable of contracting as not to have a drop of fluid in them which is effected from the great inequality of their inner surfaces, hol=lows, & prominencies, otherwise it would have been impossible.

2. Arteries wch are distinguishable enough from the Vein. The two great & principal ones are the Aorta & Pulmonary, all the other are from these, We shall speak,

1. Of their Solid Matter.
2. Their variety in this respect.
3. Their form & figure.
4. Course, Flexures, & Angles.
5. Communications.
6. Various Terminations.

First, of their Solid matter. They are composed

of

of a number of concentric coats. The most internal is of Cellular texture which can hardly be distinguished from the surrounding Cellular texture, but is densest nearest the Artery & so very dense when quite in contact that it hath got the name of a distinct coat that has been called Nervous; this is particular in Brutes, and more in Males than females & this shews that the firmness of the Arteries greatly depends on this Coat. — Next comes what is called the Muscular Coat. — whether it is such is a question. Nicholls and Hunter have declared in the negative. It is certain that it has an Arrangement, but by it's great density is very different from any other muscular fibre, it is more like a Tendon or Ligament.

To this has been joined that the Arteries shew no Irritability. Haller adopts this — Verschuir declares they do; but of this by & by. Next under this is a layer of Cellular texture — then the internal Coat — such in general is the Solid parts of Arteries.

Second. Variety of the different Vessels with regard to their solid matter. The strength of the Arteries is very considerable both in resisting Dilation & Rupture. The Aorta of a young

man

man was broke by 132 ℔ ascended from it.

By a set of accurate Experts, made by Dr Winthrop Jun.ʳ the force or strength of the Arteries appeared deficient in different parts; it is greater the further you recede from the Heart. how far this extends is difficult to say. We may however say that the strength encreases as we recede from the Heart. At the same time the density encreases & appears that the thickness of the Coat is less to less with respect to the hollow or cavity. These Experts of his are as yet but imperfect.

Third. From figure & proportion. A transverse section wherever cut is circular; this is proved by Dr Keill. Haller thinks that this regularity proceeds from a sufficient general flexibility. We may suppose that neighbouring pressure may alter this form. It is in every part nearly cylindrical, some have said that they were also conical, but this is very doubtful, and I am sure not so much as has been generally imagined, indeed it is denied at present. If you take one Ramification you may call it a Cone whose base is in the Heart; all the branches are however longer than the trunk. Here we have a Cone in a different direction whose base is in the Heart,

Heart, yet there are examples of arteries being
enlarged between two Ramifications, but this is
far from being universal, for in general the branch-
ches are generally larger. The Position that I have
been afraid is not well founded, I order no
general & constant proportion obtains. Of this
hereafter.

Fourth. Course, Flexures & Angles. They are gene-
rally directed different from the Trunk they proceed
in a direct line especially when they send off
Ramifications or where they happen to exist
Circles of different degrees of Obliquity. In the
Lungs there is a continued Braid in the Arteries of
the Branch with Flexures & Curvatures (almost)
Ramifications which always produce Flexures.

Upon this subject of Ramification much value
has been taken of the Angles at which branches
go off. It is a thing almost Occult, never believe
that I know. — Haller thinks the most common
Angle is one of 45 degrees & that the Largest branch
ches pass off at the least Angles. Aquapendente
have not properly distinguished between An-
gles or Ramification and Deviations, there
when the Artery deviates into the Line of
Ramification, where the Branch goes off there is an Angle

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Fifth. Communication of Anastomosis. The first term is well enough understood, the second remark that they are more frequent as we go from the heart & are at length to form net works as fine as hairs. Some are however several inches in the extremities of Arteries. Some are like the hairs of a Brush, others like the branches of a tree; some like convoluted tubes. With regard to the Anastomosis, which proposes a curious question, whether when Arteries pass over to different sides as in the hand, do they inosculate or not? — Erysipelas will sometimes only occupy one side & the Anastomosis can inject on half of the tongue. But yet Inflammation gradually creeps over from one side to the other. Now if we admit of Inosculation we can account for the spreading of Inflammation, if not we must seek for some other.

The Arteries are distributed to every minute part of the body. All inorganic parts are found composed of Cellular Texture condensed, and have no Arteries, all others have.

Sixth. Various terminations of Arteries. Terminations of Blood vessels are of three kinds

1. Into veins which are no more than Arteries

reflected

reflected after which there are frequent Anastomoses.

2. Where the Arteries open into cavities, into some of which they powred blood, which is again taken up by the Absorbent Veins, such are in the Vitis Uteris &c. Haemor.

3. Where the extreme Arteries go off in serous or lymphatic arteries. The Arteries terminate in this manner

a. Into serous veins: these have never been shewn to the Eye sight, but since we can inject the part which we suppose pass off from thence by the veins.

3. Secretories, termin ate thus,

aa. In cavities

bb. To throw out Excrementitious matter.

VI. Ichnilents. It is a question here whether the fluid comes out here in this state or in vapour, we incline to the last. With regard to this accurious question hath arisen about the numerous subdivision of Vessels such must depend altogether on the subdivision of the blood. But this is denied by Haller, to whom I must refer you. His Arguments are

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1. That we can pass Injections into the Secretories.
2. By various diseases the red globular get into them.
3. Veins. They have this solid substance no more than the Arteries, & are composed of cellular texture & an internal membrane, but they are so thin that it is hard to speak of them with precision. It is doubtful whether they have muscular fibres, it is plain they have something like them near the heart, & perhaps at a greater distance they only escape our notice. These thinner coats of the veins are stronger than their correspondent Arteries especially in the beginning of life or in Youth, yet this proportional strength varies until at length it comes over to the side of the Arteries. Upon the whole I should reckon that the veins have a muscular coat thro' the whole System or such a coat as I think we shall demonstrate to the Arteries. The veins tho' thinner & denser are of a greater force of Cohesion than their correspondent Arteries. The veins as we recede from the heart have an increase of thickness

in

in their coats in proportion to their cavities. These particular proportions hold absolutely during the whole of life, but then it differs much proportionably. The Arteries being always exposed to a greater pressure than the Veins must always be giving upon them in proportion of their density, but since all the Experiments of this kind are few & rarely made by one person, we cannot trust too much to them. But in the Animal Oeconomy we must not attend so much continually to the absolute force of Cohesion as to their Flexibility, and we stand want Experiments on this head.

In my last year's course I made some Observations on Aneurisms & Varices; this at present I shall omit.

All I said of Circulation, Functions, Trunks, branches &c. of Arteries agree with the Veins. Tho' since the number of Veins is greater than that of Arteries, the Reticulations, & their Anastomoses more frequent. The Veins have Valves that the Arteries have not; of this by & bye.

As to their Terminations, or more properly, Sources, they are of 3 kinds.

1st,

1. From red Arteries.
2. From colourless Arteries.
3. From Absorbent vessels, wherever the Arteries have not red blood. Whether there are any veins that are to be called colourless Absorbents is, doubtful. The Arguments that were formerly thought conclusive on this head are by no means at present thought to be such, besides it is not demonstrated that the Absorbents terminate in valvular Lymphatics, yet some thing may be said for the venal Absorbents, & it is a point I would not give up tho' I must confess it is but doubtful. Besides no Lymphatics have yet been found in the Brain tho' there is a quantity of fluids poured out there, and in Ecchymosis we find that the red blood is taken up; indeed here we suppose there to have been a rupture, but even yet it might be evident to be taken up by the Lymphatics themselves.

I do not think it necessary here to take notice of any particularity that may occur in different parts of the venal system; as for the valvular Lymphatics themselves I must imagine you are all acquainted with [illegible]

them, at least for the present.

II. course that the blood observed, for this I shall entirely refer you to the Anatomist, as it is a thing I cannot conceive any of you to be deficient in.

The proofs were also known & declared by Harvey except the single circumstance of joining veins & Arteries which is now sufficiently well demonstrated.

We know by the alternate rising & subsiding of the Groin that it is occasioned by the difficulty of the passage of the blood in the end of Inspiration; this occasions a kind of distension over the whole System. Besides when Inspiration with the thoracic we often see a kind of retrograde motion which continues in some small Arteries for a little time, but neither this nor the last are any exceptions to the general rules of circulation.

I should here observe that the circulation is very different in the fetus to what I have been relating.

We must consider the blood in the Heart as alternately stagnating and flowing. The motion of

of the two Auricles & of the two Ventricles are respectively severally synchronous; as to the time in which their motions are performed there are various conjectures. The Systole is quicker than the Diastole, but that the former takes no more than one half of the time of the latter is by no means established, neither is it possible to ascertain it.

III. Power by which the Blood is moved.

I. The Heart. This is almost by every body thought to be the principal power applied or employed. It is truely a muscular power, & analagous to that exercise in every part of the System. What is it that excites this Contraction? It must be either a vis Nervea or a Stimulus applied directly to the Muscle itself.

1st Then with regard to the Stimulus. This must either be Distension or Acid, to this last must either be mechanical or chemical. As to the Mechanical no body admits it but as to the Chemical it is by no means demonstrated, & tho' we might suppose Acids yet this constant application would at length render them of none effect. It must therefore be to Distension

or

or the Influx of nervous blood that we are to have recourse to, to it alone; muscles may be acted on by a vis nervea, & this is under the power of the Common Energy of the sensorium. The question is whether in every contraction a vis nervea is employed, but independant of the, simply the vis Nervea is concerned. This I take from the effect of the Passions alone, & from this consideration I would call the Heart a voluntary Organ. But whatever be the cause let us now enquire into the force, wch has been frequently attempted by good Mathematicians & Physiologists; but as to the solutions of the former the Physiology whence it is so difficult to ascertain the data upon which they proceed that I am inclined to reject them & the calculation drawn from them as uncertain; besides no two of them ever agree, may we far from this that they differ for upon this very principle on which they build, Borelli has far overshot the mark making the force of the Heart 180,000 ℔, Keil seems much under it.

Dr Hales computed by observing how high the blood would ascend in Glass tubes & computed that

that the force of the Blood circulating is as 60 lb, but I must own I dare not use this, for it may be said that the force is greater as it not only bursts the blood in the Tube, but also in every other part of the System; this should make it appear greater. In the other hand since as reason of resistance proves a stimulus it may be said that in the present case the heart exerts much above its natural force; besides its sustaining the column is the effect of a repeated number of Pulsations by most of a single one, hence daily says that instead of six feet it should be perhaps only 16 inches, so much are we wrapped up in obscurely & want of foundation.

II. The next question is with what velocity the Blood moves. If we knew exactly the quantity thrown out at one Systole & the Area of the first vessel we should be able to clear this up, but as yet a single point is not determined. Hales thinks that the Blood moves 50 feet in a minute, Lancisi not half so much. We see then that these two famous questions are nearly as far from being determined as they were 100 years ago. — Undoubtedly the Blood moves more

more & more slowly the farther it goes. Let us now endeavour to discover the causes of this retardation.

1. In an Animal in health the Arterial System is constantly full, consequently in every Systole it should seem that so much of the Hearts force is lost as is required to dilate the Arteries; but when when contracting the Arteries return upon the blood the sole force that was expended upon them by the Heart. The loss here must be very small, but besides this the Arterial System must lift the whole of the compressing Atmosphere at every pulsation, but here again the same force is returned as given.

2. The other resistance is that of about 30 lb of blood that is to be moved; this can but with difficulty be applied to any purpose, for it is nearly equally balanced & does not give any general retardation.

It is said that the capacities of the Arteries are constantly encreasing, hence the force of the blood must be continually decreasing, but what is exactly the effect of this is hard to say, tho' I do not suppose the increase to be much to therefore

therefore the force lost in the blood from this must be trifling. I do indeed allow that some small enlargements take place but we know nothing in what proportion, and as to any general & exact rule I believe does not happen, & this is also allowed by Jurac & Hallot, they even think that there is in some places rather a diminution than an Enlargement. Observations shew that the motion of the Blood in the small vessels is greater than it could be on any supposition of this kind

4. Another resistance is from flexures & angles, this is as difficult to be estimated as any of the other. All these flexures are Elastic & therefore must return the force lost upon them, it is their friction alone that is to be regarded here; Many forcing matter makes a flexure it is a real resistance, but even here we can suppose that at some times there may be a dilatation equally favourable for the passage of the blood. All flexures when the Arteries become bent I suppose there is always a resistance.

5. Another cause is the Angles at which the

Blood

blood passes off. This is a very different question & there are disputes about the very principles we are to reason on. This however I think is but inconsiderable, & neither from Injections nor what we find in the human body can we suppose it to have any great effect. I very much doubt whether in any place there is a vessel that goes off at right angles but always at an acute angle. In general these going off of vessels are more properly denunciations than Angles. Where Angles become frequent they are almost all of them Ramifications. Where then admit of no calculation for all is precarious. I had almost forgot to take notice of that celebrated problem of the alternate Contraction & relaxation of the heart. It is now easy in comparison of, what it has been; many solutions of it have been offered but none of them are satisfactory & you yourselves will see that they are without foundation.

It is by considering the Heart as a Muscle that is capable of being stimulated by Distension. The venous blood is what produces this Distension,

&c

but besides this the heart is in various instances under the influence of the Nervous; it may seem odd that it is not liable to Spasms, of such I have heard no instances; it may also seem odd that the contractions are not more vermicular.

There is something in the nature of muscles not attempted to explain before that it requires the motion to be alternate, thus if we cut a heart out & stick a needle into it & die it let it remain as much as you please you will find that the ventricles will be alternate, and even this law of Muscular fibres should be, and becomes so in accounting for the alternate contraction of the heart by the Nervous blood.

I now return to the Resistance of the passage of the Arterial blood. I have already spoken of most of them.

6. Anastomoses are another circumstance. This is something but it is difficult to say what to how great it is, & perhaps they are of greater assistance than Detriment, at least upon the whole it appears as it may hence with regard to the force of the heart it would be nearly balanced.

(J. Hutton

7. Friction is the first resistance to this we know takes place in every communication of motion, this I think has been very inaccurately considered. Friction is of two kinds

1. Inequality of surfaces. This is taken off by polishing the surfaces or by frictions wheels, but this friction cannot take place between solids & fluids, for a fluid is compared entirely on frictions wheels. There is a resistance that arises from adhesion of surfaces which hath been confounded with this, and this is increased by that kind of polishing which destroys the former. This may take place in the Celestial System, but how great it is is not in our power to say. This differents from difference of matter and principles particularly in matter of the same kind. I do not think we have any reason to suppose that in any circumstances there is a repulsion, there may indeed be more or less adhesion, but I know of no instances where there is a repulsion.

Now in the Celestial System it is the application of a fluid to a fluid solid and not to a dry one. There may be some resistance from the

supposed

suspected viscidity of the animal fluids, but this was wholly improperly to the living Animal for the heat keeps it fluid. It is very difficult to say why the red globules of blood have so little attraction with each other. We supposed the disinclination of the parts of the blood to be in a diffused state to that its particles have very little attraction to each other, this & the several powers applied keep it fluid. Now in the great vessels we suppose that also the parts circulate intimately mixed together, and I do not believe that there is any part in which the red globules have all manner or without having some other fluid along with them that is in the blood.

Thus I have endeavoured to lessen the resistance from friction considerably but yet I would not pretend to say that they are taken off altogether, all that I say is that it cannot be computed, and little conclusion can be drawn from Dr Hales Experiments, while left from Experiments in the Berlin Memoirs. In Hales Experiments the resistance seems chiefly to have arisen from the Constriction of the vessels, especially those that are made by Arterial Glands.

&c.

All that I have endeavoured to prove is that the resistances have always been computed too high. Most other supposed resistances seem to be of little or no weight, we shall have recourse to the muscular coat of the Arteries to overcome these if we can prove the existence of such a Coat.

There is then no power we can have recourse to but the Action of the Arteries themselves; this then is a point of the greatest importance. The doubts that have arisen proceed from our not being certain that the Arteries have muscular fibres. The muscular Coat has been doubted by several very great Anatomists from its appearance, by Nicholls, Hunter, &c and Hales, because they are not visible as he says, but this is contradicted & found to be Muscular by others. Since I may. All the Arteries we can examine have a sort of fibres that seem to be Muscular but different from any others of different parts, are very tender & more like tendons or ligaments than Fleshy. Something in the Respect of Hales seemed like irritability from chemical stimuli, but these of no consequence for or against the doctrine or opinion. Hales seems

seems to have examined chiefly in dead bodies in a contracted state when it was impossible they could shew any irritability. Besides, the Experiments of Verschuier put this affair beyond a doubt.

From what has been said before, this question of the Muscular fibres of the Arteries may be managed in different ways.

First, we may suppose that the Arteries have muscular fibres thro' in a less degree than in most other parts. This I think cannot be denied if we consider that many Muscular fibres become Tendinous & therefore there may be intermediate degrees of contraction. As for Dr. Hallers Experiments we may say that they were made upon dead Animals consequently in a contracted state; besides these Experiments are remarkably nice. The insufficiency of the heart for the circulation in all cases with absolute incapacity in many proves this, and the diseases of Arteries prove it beyond a doubt. But yet all this proceeds on calculation. I shall read to you the accurate Dr Verschuier who has demonstrated this before the most learned Professors at Gottingen metropolis of Hessia, he yesterday was present at a Lecture

which

which prevented one from commenting upon them. There is so great an appearance of candour seems from the whole of this Author that I cannot doubt of the justness & accuracy of his Experiments. I think we have many confirmations of this doctrine in the morbid phenomena of the body, as topical Inflammation, Palsy, Gangrene &c which prove that the blood is distributed unequally while the action of the Heart continues the same.

This might be said depends upon unequal resistences, but I think they depend also on the irritability of the Arteries, and after all I conclude that the Arteries are an irritable part of the System they perhaps have so thin muscular fibres, it plainly appears by experiments the natural stimulus, which may be, the the forces of the propelling power of the heart, and this commonly makes it correspond with it, but we see it can differ, altho' it generally acts from one stimulus, yet particular stimuli can produce differences in different parts. Secretion of the Blood depends upon the conjoined action of the Heart and Arteries. As to the oscillations of

Dr

Dr Whytt. I neither understand it nor can I apply it. I conceive that the irritability of Arteries may be extended to a great length in so very small Arteries. The action of the heart may only proceed to certain length, after this says Whytt the action of the Arteries alone perform the office entirely of prospelling the blood. He supposed that it is like the Vermicular motion of Alimentary Canal by which the contraction of an upper part necessarily excites the next adjoining: thus, take an Artery of an inch long the contraction first takes place in a tenth of its length & propelles the blood into the next tenth which is now excited to contraction, & thus on to Extremity, & he imagines that the force of the Heart fills the beginning or first tenth part of this Artery, & this Artery acts itself. This is his meaning if I understand him right. Thus when dilatation gradually proceeds towards as a stimulus, according to Whytt it may be possible, may I think such dilatation do sometimes take place even in the smaller Arteries but not in the manner Dr Whytt supposes for I rather found that upon stimulating an Artery the contraction proceeds

fast

for a great length even into Branches of the Artery, but in the smaller Vessels it is more doubtfull, because the Experiments shew that it does take place, tho' this indeed is but an Argument of very little weight because of the Extreme minuteness of the parts, & Haller's Microscopical Observations made on Frogs &c, where he says that extreme Arteries are not related by the blood & that they are merely transparent fine canals or tubes but these make equally against simple Elasticity & yet he himself says that these Vessels are taller & more turgid after pressure.

Dr Whytt has endeavoured to establish this doctrine by Calculations on the force of the heart not being able to push the blood thro' the whole of the Arterial System, but I have before given my reason why these Calculations cannot be just, he Injects the Hypothesis entirely for the Action of the Heart. We know that we can push the blood thro' the whole of the Arterial System into the Vein, and we find that no more force is required in Injections to push them into the secretions, and we don't admit numerous series of decreasing Vessels as some have done.

General

Several Glands are but little affected by the Motion of the Heart, but on the other hand we find that most of the Secretions are increased by the increased Action of the Heart & Arteries. Respiration which is one of the finest Secretories is in a great measure dependant upon the action of the heart & Arteries, & Secretions are generally in proportion to the Excretions, hence by stimulating the Secretary Vessels we promote Secretion, & where this does not take place there may be reasonable cause. provides for the more easily of the Vessels.

In Plants there is a motion of fluids in certain Vessels that there is no heart to impel them, now the quantity absorbed is influenced by the quantity exhaled, & something like this may take place in Animals. We see in the Leaves that there is a fluid or liquid which Exhales is evidently supplied from them but in a regular that there is a peculiar connection between this & the other therefore have heard me speak of so much, and this may not be more Electricity does in Plants.

As to any supposed Stimuli existing in the blood I entirely reject, because if there was Stimuli would alternate & render them of no effect

therefore reject this accessary motion of Dr Hall's as neither necessary nor probable. Having now considered all the motions or powers that take place in the Arterial System,

Let us next consider what causes the return of the blood from the veins. This depends upon the same power as that of the former, but then the resistance here is so great that the blood is liable to stagnate in different parts of the System. The very rising of the blood contrary to its gravity is a very considerable one!

Many hypotheses have been started to account for the Motion of the blood, most of which we shall not mention, but Dr Haller is a person of such reputation that whenever he is in an Error we are enamoured under the necessity of pointing it out. v. 191

Dr Boerhaave has shewn fully of this opinion that the veins are variable. This is universally allowed in the dead Body, & it is to be observed in both — the Vena Cava, but not to the same visibility of the extreme veins I doubt it much. We cannot suppose the blood to be more fluid in the veins than Arteries as Haller does, nay on the contrary it is just the contrary except in the Subclavian

veins.

whereby the Lymph is poured into the Venous Blood in it's way towards the heart. There may indeed be a considerable absorption by the Veins. We believe the red Veins to be Absorbents, but then it cannot exceed the Exhalation from the Arteries except where there is an Absorption of humidity from the Villous - tunic which may sometimes happen, yet we know that Absorption in general is performed by the particular Lymphatics which only communicate with the Venous blood in the manner just now mentioned.

The regular return of the Venous blood is only carried on regularly under a proper degree of Pressure, a principal power from by which the Venous blood is carried onward should seem to be the Action of Muscles. As to Respiration since the neighbouring parts yield so much it can have little effect. The Action of the Muscles since they become less during contraction much both press the adjoining vessels to force this blood forwards wch is prevented from flowing back again in the Veins (even tho' there should be a degree of Vacuum found in them by the valves, to squeeze the blood out of them) since. It may perhaps be said that this would likewise prevent the Arteries from carrying on towards this blood. To this it may [illegible]

if this action was long continued, otherwise not; and the valves must make the determination of this blood certainly towards the Heart.

Air is an Elastic Gravitating fluid which always preserves itself in Equilibrium, but it's particles repelle one another from whence arises it's Elasticity, but being a gravitating body it will be denser at the bottom, hence we have a quantity of Air in a vessel it will be of the same density & Elasticity as the common Atmosphere which is different in different degrees of heat - thus it must also be in the Lungs - Heat rarifies, Cold condenses it.

I must suppose you acquainted with the Anatomical Structure of the Lungs. The Substance of the Lungs is a hollow viscus yet they are divided into innumerable Cells wch are also pervious to the Air, & there is a great deal of nicety in the structure of them. They are covered externally with a proper membrane besides the Pleura that it is pervious to the Air.

There is only one passage the Trachea or Asperia Arteria by wch air can take into the Cells of the Lungs, but then this is again divided into many smaller branches that open into Cells which communicate freely with one another

Upon these cells there are spread innumerable blood vessels, called Pulmonary, wch ramify upon them into a prodigious Minuteness; these vessels & cells must upon suffer a peculiar compression at same peculiar times or in Inspiration — We shall now proceed to Explain

Respiration which is the alternate admission in & undischarge of Air from the Lungs, and

1. The power by wch Respiration is performed.
2. The effect it has on the motion of the blood.
3. Why these Motions are alternate
4. The change the Air itself undergoes.

First. Powers of Respiration. We must consider the Lungs as bladders capable of being enlarged or diminished; thus suppose we have 2 or 3 bladders confined in a large one we know the same effect is produced upon the outer one whether we blow it by blowing Air into it or into the smaller ones contained in it, thus we may consider the Thorax as a large bladder & the cells of the Bronchia as the smaller ones.

The Diaphragm is naturally convex towards the cavity of the Thorax from its attachment to the Mediastinum &c; and if we make a contraction of

its fibres it will no more be brought into a Plane which enlarges the vertical axis of the Thorax which can also be enlarged in its Horizontal Axis as bounded by the Ribs and Sternum, if these are moved, being fixed behind, they must be pushed forward and outward or the Ribs from having an Angle before they arrived at the Sternum must be brought nearer together, and thus the capacity of the Thorax is enlarged.

The question of the Action of the Cylindrical muscles is now well settled that all intercostal muscles in general assist in elevating or drawing the ribs closer together. These muscles & the Diaphragm are the powers by which the cavities of the Thorax are enlarged. The Diaphragm is the power generally employed, but whenever it is insufficient the Intercostals are called in, as in (Pregnant women & dropsical people, hence these are assisted by the Muscles that are attached by one extremity to the Thorax, the other to the Shoulder &c.)

The capacity of the Thorax can also be diminished, for as soon as ever the Muscles slacken their

cords

parts above mentioned is taken off the Muscles power of the Cartilages and membrane restore them to their former natural situation, & the ribs, diaphragm, & thorax will be restored to the situation they were in before Inspiration. The Action of the Abdominal muscles, the Sterno & Infra Costales may also assist in this by drawing the upper ribs towards the lower, & in violent exspirations the sacro lumbalis, Quadratus, Lateralissimus Dorsi are frequently called into action. The Elasticity of the lungs themselves, both the cellular part, the branches of the Trachea, and the covering they receive from the Pleura makes them disposed to recover their former collapsed state, especially the Muscular fibres of the Bronchiæ and this great Elasticity.

This alternate admission & Expulsion of Air or Inlargement & Contraction of the lungs & the effect it has upon the Blood may be easily conceived from our Simile of Bellows.

There are Experiments to shew that the Respiration does not always stop nor the lungs entirely collapse altho the Air be admitted to the external surface of the Lungs by an Aperture into the Thorax, May they

more

were even pushed out & distended thro' the whole to a considerable bulk &. Mr Bremond found that Respiration did cease for 3 or 4 times after he had raised the Sternum & opened the Thorax. But in these Experiments we are to take notice that the Air which gets into the Lungs is soon heated above the temperature of the external Air & consequently is satisfied with Elasticity encreased in a similar manner to a Bladder not quite full of Air is distended by heating it. This is sufficient to explain the above Phaenomena. After an Animal has once breathed its Lungs are never quite freed of Air, but a small quantity is taken in or expelled in each Inspiration or Exhibration.

We come now to consider what are the effects of Respiration upon the Blood, suppose the Lungs in a collapsed state. Now if the Air enters in it dilates & fills the whole Air Vesicle & enlarges the Thorax & Membranes upon which the blood vessels are spread; this must therefore expel the blood thro' them, but if this state be pushed on & carried further it must compress not only from the Elasticity of the Air contained but also from more pushing in so as to prevent the free

pass-

transmission of the Blood and an uneasiness &
sense of Anxiety will be produced which prompts
us to expel the Air by Inspiration.

Inspiration is a strained violent state brought
on by Action of Muscles, & from what we have said
of muscular fibres a relaxation must naturally suc-
ceed. When the lungs are got into a collapse-
ed state the blood cannot move freely thro' them
but is stopt in the Sinus Venosus Jugularis & Vena
Cava descendens regurgitates in them brings on
an anxiety which forces a stimulus & hence the
Muscles are again put into a state of contraction
& this Inspiration is again produced.

This I think is a simple easy solution of the
alternate Contraction & Relaxation of the Lungs &
Organs of Respiration which depends upon the
passage of the Blood being more or less free.

Besides this certain changes happen to the Air.
—Air by being long breathed loses it's Elasticity,
as if confined in the Lungs too long. But this is
so little in one natural Respiration that it cannot
be much affected. If the same Air once taken in
was constantly to remain it would become unfit
for the purposes of Respiration even Animals

so

to Animal life.

By an effect of the Animal Economy not yet explained there is constantly arising from the Lungs of Breathing Animals certain Vapours not destructive to life, and the effect of Air is to mix with this to carry it out of the body, but if the passages be for sometime stopt the Air at last becomes as if it were saturated with it and absorbs no more, Whence its deleterious effects upon the System, and this also is the reason why Animals continues to breathe for a short time after the Larynx is shut. The nature of this we know from similar Air rendered in various manner, as if a portion of Air be confined for any time upon the surface of the Earth it becomes of this nature by Vegetation. Fermentation also arising from effervescing & fermenting substances, it is very different from common pure elastic Air but in what is not yet determined; it is called fixed, or more properly Mephitic Air.

This is entirely rendered mild & harmless by being mixed & diffused in the common Atmosphere, but whether this happens from mixture or merely dilution

discussion is not at present our business to explain. In the business of Respiration merely it is intended to procure a fresh supply of Air.

1st. Vesphitic Air be allowed to remain in the system it produces Death by destroying the Mobility of the Nervous Ether. My ingenious Colleague Dr Black has already explained our knowledge with respect to this substance. This I suppose to be all necessary for understanding Respiration but I cannot here consider the change it induces upon the blood by separated exposition to pulmonal air for but this will more properly come under the head of the Chemical part in the Animal Economy. What I first say came to the effect of the circulation of the blood. Air is in the effect of the circulation of the blood. Air is not the cause of the generation of heat in the body but at least distributes it to every part.

2d It gives a due degree of irritation to different parts of our system.

3d It gives also a tension to the several solid fibres of our system & it must stretch constantly the organs and every muscular fibre:

There are Chemical other effects, besides these, to

&c

be considered. The Blood when circulating in the larger Vessels is an heterogeneous mass, from which various secretions are made by a sort of Colature or draining thro' parts that are filled to let one part of this Mass pass but not another. This is called Secretion & is one of the chief purposes of the System & to effect which the Vessels must be divided into a series of ever smaller & smaller Vessels.

We shall find that the preparation & application of Nutriment depends upon the state of Secretion. Secretion & Nutrition, these remain to be shewn more particularly of.

The Original Stamina are prodigiously small portion of matter in comparison of the whole Built Animal Machine. The effect then of the circulation must be capable of preparing matter fit for producing the Solids which are still made from the fluids. This depends upon changing one mist by forming another, but this belongs to the Chemical part of our Science; to which we shall now proceed.

Of the Chemical System.

Chemical System

This, like many other parts of our System is still on a very uncertain footing. What can be delivered with accuracy and precision I shall lay before you. This I shall be able to comprise in a small compass.

In our consideration of the Doctrine of the Animal fluids I shall be guided by chemical principles from whence I demonstrate this part of our Institutions the Chemical System. The System has been treated in different ways by Physiologists. Dr. Hunter considers the fluids as already formed in the System, and afterwards enters on the consideration of the constituent parts and the mode of their production. Cheyne has followed the contrary plan, and begins with the Constituent parts of our fluids, the matters out of which our fluids are formed & this Animal matter from them, and the progress of the changes produced in their conversion to the Animal fluids. The advantages of this latter method in clearness & simplicity are sufficient reasons for us to prosecute it.

It has been customary to introduce Nervous Mechanical, Deglutition and Digestion

but this I shall not attempt at present, some little matter on the action of the Alimentary Canal.

In studying the nature of the Animal fluids I consider them as formed of the Element taken in, & we shall endeavour to discover the gradual change they undergo in their conversion in the Animal fluids.

I set out with a position that our fluids are formed from the Element taken in, from whence is derived the gradual accretion of bulk in Animals. Whether the primary sources of increased bulk we shall trace in the consideration of the Air &c, but these I say they deserve our attention, and we shall confine ourselves to the Element or the matter from which our bodys derive their increase.

In order then to consider the manner of nourishment we ought to observe that the body is throwing out very constantly, considerable quantities of matter nearly equal to what is taken in; therefore the whole of the substance after sometime may be supposed to be formed entirely from the matters taken in. How then is this produced? The Element is vastly different from the matter produced. Most Animals feed on Vegetables — You will urge I shall that these are animal that live entirely upon other Animals but

these

hence you should reflect that these Animals such they devour were originally fed on Vegetables, and thus, it is not difficult to trace the whole of Animal matter from a vegetable original; but here however a considerable change is brought about, we must enquire in what manner.

From the moment it is taken into the mouth we may suppose it to undergoing some change, but the chief part is performed in the Stomach, for the other are only preparatory. The operation of the Stomach are only preparatory. The operation of the Stomach may be reduced to three heads, Solution, Digestion, & Assimilation.

No change or solution can take place in solid matter, unless it be united with one in a fluid state, hence the necessity of Solution. We see that those are the same matters which neither suffer or Solution or intimate mixture, here we suppose it only to be divided or blended with the fluids contained in the Stomach; this is Digestion. There are also changes produced in the nature of the mixt, this are name from its ultimate effects, Assimilation.

1. Solution is produced or performed by the same means in the Stomach as by every other Chemical Operation. The solid matter is first divided

. Manducation and then infused in a proper menstruum that is capable of dissolving it. The whole mass is likewise kept in constant digestion & in a moderable degree of heat; these we shall consider separately.

1st The Menstruum. Many hypotheses have been started on this head, but it is now universally allowed that the chief is the fluids we take in. This in most cases is pure Elementary water which makes 99 parts of 100 of the drink of the whole Animal creation, & the human species this is the basis of every drink. — By frequent trials of water little alter'd its solvent powers, and we find in numerous instances that solution can be perfectly performed, hence we conclude that Water and Water alone is the chief Menstruum of our food.

To this we may indeed add the Saliva & Gastric liquor which transude from an infinitude of Arteries that open into the Stomach & Intestines, & which is very considerable as we learn from the Experts of Mr. Monro. There is also a great quantity of Mucus different both in colour & quality from the gastric liquor. There are likewise several other Animal liquors occasionally thrown into the stomach that were originally separated in the Intestines, but

upon

upon various occasions regurgitate to get it to the stomach. But we have no Chemical Reason that proves that any of these have a peculiar solvent power above water, therefore to supersede any further needless enquiry we should have recourse to Water alone as a Menstruum or Solvent, assisted by the other powers of Division, Agitation, and a proper degree of Heat.

2.d In Animals the matter is chiefly broke down by Mandication wch is a pretty intimate division & a sufficient operation preparatory to the Action of the Stomach.

In the Schools of Physic, particularly in those of certain country, it was formerly imagined that the stomach had a power of Trituration. This was taken from the Analogy of Birds in which there is a necessity of that nature occurs, for the gizzard is firm & solid in its texture. We see me to serve the office of Mandication by another Mechanical power Trituration.

But we have no reason to suppose a similar operation takes place in Man the sides of whose stomach never come into intimate contact & is so tender an organ that it could never produce or bear any such

operation

observation. May we find that if any matter of great firmness be swallowed it passes in it's entire state thro' the intestines.

3d But the stomach may constantly agitate the mass briskly distributing to every part of the matter to be dissolved. The effects of this are easily understood by every one who knows any thing of chemistry, for our food is generally of less specific gravity than water, and hence the necessity of constant agitation to keep it mixed with the fluids.

This agitation is performed by various powers — 1. The peristaltic motion of the parts. 2. The motion of the stomach in consequence of it's connection with the Diaphragm, this however is but of little importance, & even joined to the pulsation of the arteries is so trifling that I reject it entirely.

4th Heat. That of the human stomach seldom exceeds 98 degs of Farenheits Thermom., and this we find to have very little power in producing a dissolution in watery Menstrua, and this Physiologists have of late discovered but have endeavoured to mislead us by a number of hard unmeaning terms, and would seem to insinuate that the Stomach

can

can receive additional heat from the surround-
ing viscera & other parts as if these parts were
heat in the same temperature as the whole system,
and upon the whole it is no more than this. If a
substance that is colder than the stomach be tak-
en in it must deprive it of a part of it's heat, but
this is soon restored to an Aquilibrium by the cir-
cumambient parts.

Besides what I have mentioned there is also ano-
ther considerable mistake, that stomach is generally
conceived to be as a closed digestor. Keller says,
the cause, which is undoubtedly a great mis-
take, for it is by no means the case of the stomach;
from this cause it was supposed that heat generated
in the stomach was there confined, but this is
absurd; for the natural degree of heat of the body
seems to be the most proper for promoting solution
in the stomach of Animal or vegetable substances,
for a degree of heat above this, viz. 150, has the
effect of coagulating them and renders them much
more difficult of dissolution. Hence the natural
heat is the most proper for promoting the diminution
of the attraction of cohesion of these matters preventing
them down.

&c

It is to be doubted whether or not we are to allow air taken into the Stomach to have any power there; it is taken in in large quantities & being colder than the Stomach it must be expanded & probably agitate the contents. Hence I must conclude that this affair of Solution is a very simple matter & that there are no saline or other acid matters applied, nor have we proof of any Juice quatre being more effectual solvents than water alone. That Physiologists have imagined these powers of Solution sufficient to answer every purpose of assimilation. It does not indeed break down the fabric of Animal & vegetable substance, but this is merely confined to the soft cellular parts, for the fibrous & firmer ones suffer little or no change here and any alteration in these is made by, the digestion taking place; this however is only to be taken in a gross & limited sense.

It affects Animal matters more powerfully than vegetable — I have known a Man take a pound of Elevated Red by six drams at a dose which also passed thro' the Intestinal Canal entire & unbruised, and so far from there being a power of Solution in the Stomach

of

of the strongest Quadruped a grain of Oats will pass thro' the whole Alimentary Canal without change. In our species the husks of the most tender fruits pass unaltered. The patient that took the Mustard seed retained it in his bowels for some weeks & I have been lately told by a Physician of eminence in this city of a patient who voided soap pills undissolved. From these facts it is plain that the powers of trituration exhibit not in the human stomach, and those even of solution itself in some cases but weak.

Physiologists say that the use in animals of the human stomach is Digestion, that is Agitation, yet we can never perform digestion or this kind of solution; this is certain & therefore we must have recourse to some other power such as one is fermentation whose power of breaking down bodies is well known, by extracting the fixed Air and making it become Elastic. But by this I do not imagine fixed Air to be the cement of bodies, as Hales, Priestley & Macbride do — Dr Hales first started this theory, that the separation was the ultimate resolution of the particles of bodies

( )

bodies; but this I am far from asserting, on the contrary I esteem the doctrine of Cohesion to be an absurd one, for Cohesion depends on the mutual affection of all the parts of a body but fixed Air being one of the constituent or component parts to the composition of it which is easily affected must produce a Coalition, but yet not so compleat as the Advocates for the doctrine of Cohesion imagine. Hence we maintain that the powers before mentioned assisted with Fermentation is all that is necessary for the solution of our food. Fermentation consists in a great measure of water & Air, both of which are found in greater or less quantities in all Animal & Vegetable substances; how the latter is managed is a more difficult problem. — Water alone is not a solvent for it & in the stomach it alone is not so much dissolved or diffused, for it is found unaltered in the chyle and even milk of Animals therefore this is not effected in the stomach.

II. Diffusion. In Pharmacy we can mix solid & water by means of Mucilages & a proper degree of Agitation & we may suppose something of the same nature to take place in the Stomach. —

&c

As to the saponaceous quality of our fluids I know nothing of it, besides I maintain a perfect soap does not in the least assist the combination of oil & water, neither do I know of any satisfactory experiment that shew any peculiar power above that of mucilage in our fluids, or even in the bile itself in uniting oil with water, on the contrary there are many experiments of Dr Hamner in which that method is much against this opinion.

III. Assimilation or the entire change of vegetable Matters into an Animal matter, or those of one Animal into that of another. This change is not completed in the Stomach, but the first step is brought about here, & indeed in some measure nearly takes place, but it is difficult to determine as to the thorough completion of this process, whether further changes towards a more perfect Assimilation takes place in the Lacteals or not seems as yet beyond our investigation.

We observe that a fermentation does take place — The Chemists who possessed the first rank in Physiology introduced fermentation & their other principles into every part of nature, but with very little

did they apply them to the Animal body. Upon this account the Mechanical Philosophers who succeeded them rejected these notions entirely, and said no fermentation happened unless in a dissolved state. However in the Stomach I think there is evidently a ferment, because all other vegetable food is of a fermentable or saccharine Nature which is the basis of fermentation, consequently it must happen in our Stomach. Besides we discharge considerable quantities of Mephitic Air which is evidently the product of fermentation; this upon separation is found to increased in bulk, hence perhaps (some may say it is only common Air, but we are convinced of its having the properties of Mephitic or fixed Air.)

Boerhaave seems to have been inclined to adopt this opinion, but on recollection that there were some things according to his notion absolutely incompatible with fermentation he was upon the whole very circumspect in rejecting it. He asserts that the heat is too great, but this objection by no means excludes the possibility of it under particular circumstances. It is not indeed the proper degree of

of heat for a vinous fermentation, but we have no reason to think that a vinous fermentation may happen even in a greater degree of heat than that of the Stomach.

Another objection was that a communication with Air was necessary to fermentation, to which I assent; but then I say we do not know to what degree this is confined; besides I deny the Stomach to be a close vessel, for Air is constantly thrown out by eructation consequently the orifice of the Stomach is not perfectly closed.

It is plain that these two objections were drawn from vinous fermentation, not the Acetous which requires a heat as great as that of the human Stomach to which we imagine to take place. — Hence therefore they cannot affect us. Again they say that Animal Substances are neither proper for vinous nor Acetous fermentation because such in vegetables are, but this is now known from Dr Pringle's Experiments to be false, for they are capable of producing even encreasing fermentation.

We cannot then doubt but that a fermentation does happen, do we next enquire as to its nature, the manner

manner in which it is conducted & with what peculiar effects. We are inclined from Jasper's to conclude that the ferment which takes place is more or less of the putrefactive kind.

Solution as I have said is the reduction of a solid matter into a fluid form by the application of another fluid; the solution may indeed dissolve the properties of the solid, but Chemistry has taught us but little concerning the natures of Mixts, & indeed only when we are previously acquainted with the principles or component parts, have we been able to draw any knowledge by Analysis; thus I believe the best Chemist would not have been able to have found out that Ether is composed of Acid & Alcohol; hence I reject the method of discovering the nature of Assimilation by examining Animal fluids already digested.

I need scarcely that in Jasper's made out of the body upon our food drawn after being received into the Stomach there is not the appearance of a fermentation of the putrefactive kind going on, but this I assert does by no means prevent the other kinds of fermentation, on the contrary I have reason to believe it rather quickens them. Neither can we say that

that there may be an hundred different Modifications of fermentation, & perhaps this that takes place in our Stomach may be a peculiar one.

In the fermentation of vegetable matters the first that comes on is the Vinous, then the Acetous, & after this the putrefactive; this is the general result from Experts, but how far this train may take place is a little uncertain, but in a sound state I should conclude that our vegetable Aliments always goes thro' these three stages. The Vinous fermentation is the extrication or development of the fixed Air; this would not more evidently taking place if there were not means provided for its reabsorption as soon as disentangled, wch may be effected in various ways.

Dr Pringle found in his Experts that by mixing Bile or Saliva with fermenting Masses he prevented any great appearance of the separation of fixed Air; we must suppose it was separated but again reabsorbed, hence I think you have many proofs of a Vinous fermentation in the Stomach. Let us examine if it be necessary for the Acetous? I think this does not take place, but it is of so short a duration as to be scarce perceivable for every

attending the process combine to push the humours into the Acetous. With regard to the Acetous I think this is established in fact; for if we examine the Authors that have treated on this subject we shall have the greatest reason to conclude that an Acid is present in every Stomach which takes in vegetable matters, and perhaps too in those that take in only Animal food

The only Objection then that can be made is whether this is not morbid. I think it is plain it is not as there is a provision made by nature for covering it to prevent its morbid effects — Besides it cannot be disputed but that it occurs frequently where there is no disease as it is almost impossible for a person to vomit without having an Impression of its presence. The covering of this I take to be a necessary dose in the combination of Animal fluids, and this Acid is supposed to be mixed with an Animal fluid already prepared, and with it forms a liquor fit for Nutrition.

After the Mechanical Philosophers had destroyed Chemical Solutions by processes happening here

Circulation

Fermentation succeeded, and these two systems Dr Boerhaave joined, but I think he have never spoke of assimilation, nay they rejected for mentation which is a necessary step towards it; he have no where recurred for the change of vegetable matters into an Animal nature; he only imagined that it was by diffusion, first in the stomach, Intestines, Lacteals, & lastly perfected in the blood where it was formed into globules.

Boerhaave altho' he rejected the doctrine of fermentation, yet could not deny but it did in some degree take place; but to abviate this he added a consideration concerning the manner it was checked; he plainly perceived that mere solution was inadequate to the explanation of the phenomena whence sought for another cause. He said that the vegetable was so totally disappeared from the mass of Animal fluids in which they were immersed, Vid. Boerh. par. 126, but this is an allusion to something after produced, this something however that makes the vegetable matters disappear renders not condensed upon. But even this system adopted it must evidently follow that from the continual changes of our bodies, the vegetable matter must at last

cease

exceed the Animal, & in the end a compleate conversion of the body into vegetable matter must take place; for in fact this is no mixture but only a diffusion or juxta position of the particles of the different aggregates, whence its nature must appear in the progress of Animal secretion — we should observe it in the chyl before it has arrived at the state of an ex. The vegetable matter however is not only covered & diffused but is absolutely changed in its nature; as to its mode of conversion & by what powers this is effected, is a matter that cannot easily admit of a determination.

In the works of Boerhaave and his followers there is a mechanical doctrine maintained, that the qualities of a mixt can be changed by a division of its parts, by which operation the veg. matter is supposed to be figured down to the Animal, and hence the former is supposed to be Animalized or totally converted into the latter. And this doctrine notwithstanding the reputation of the philosophers who maintained it, I assert to be fundamentally false, & the present state of Chemistry makes us sensible that no changes can occur in the qualities of bodies but what must be referred to Separation

one

& combination which we never can suppose to take places among the constituent parts of bodies by the mechanical means of friction, trituration, &c. In reality mechanical attrition is unable to effect a change in the nature of bodies, they merely undergo a subtile separation of parts but no alteration of their properties.

The Doctrine of Boerhaave, as to the particles acquiring a Spherical figure in consequence of their passing thro' the canals of a determined size must therefore give to the ground, as this change of bodies by Mechanical power alone is contrary to the whole analogy of nature.

The Modern Philosophers & some few of the antients imagined that all the alterations to which matter is subjected is simply an alteration in form, but that matter in respect to its constituent parts continues permanently the same. The fundamental parts, according to them, are Atoms formed by the supreme Creative Power, similar to each other, Insecable & Indivisible, perfectly immutable by any powers, and from the different proportion of combination of these result the variety of material forms. To explain the means by which such Arrangement is effected appears impossible, but

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a Mechanical operation is by no means sufficient in regulating the position of the particles. Mr Boyle throughout his works has taken great pains to demonstrate this doctrine & coincides with the opinion of the qualities of bodies being dependant on separation & combination, hence Mechanical Attrition can produce no alteration on the qualities of Bodies.

M. Gaubius observing how doubtful the fundamental doctrine of Boerhaave must appear objects but with great diffidence, & within Sam of opinion, that we are to investigate the production of Animal fluids by chemical means: this method has indeed been adopted, but in consequence of that the whole referred to fermentation of the nutritious kind, hence Dr Stevenson has employed the hemistick simile of comparing our bodies to a smoaking dunghill.

Boerhaave is far from being satisfied as to the quality of our Animal fluids, or their being formed from the aliment taken in. The Animal fluids are formed undoubtedly from the vegetables, the aliment whether vegetables or Animal is fundamentally the former

former & our conclusion must bring them ultimately to a Vegetable Original. Vegets are absolutely essential to Animal subsistence & hence must be the fundamental basis of all Animal matter.

The instances of actually putridity found in the human body are but rare, but the consequences of long fasting & the scurvy incline us to believe that these would be a general & universal state of putrefaction in Animal bodies, if there was not a renewal of Vegetable matter.

But the principal question is — In what manner is a Veg. substance converted into an Animal nature? Two ideas present themselves to us on this subject, that Vegs in the course of fermentation are changed to an Animal nature & are rendered stationary in that condition for sometime, but of this we have no explanation & no such progress in fermentation is to be discovered. Another opinion is, that the matter is composed of a Vegetable wch unites with an already formed portion of our Animal fluids, from this union a tertium quid is the result, & hence we have formed the salutary Animal mixt.

We presume that it is in this last way that our Animal fluids are formed, not strictly from Vegetables but partly from these & partly from our fluids previously

-ously animalized. In what condition then is the veg. when united to the Animal matter? A presumption here lies that the veg. in some process of fermentation is applied in order to form the Animal mucl, but what is the precise state of the veg. at the time of its application does by no means appear. The matter in proceeding to the urinous fermentation may be stationary, & this for any thing we know to the contrary may be the period of union; but the fermentation in our common operations is constantly proceeding & is found in the Acetous state in the stomach, hence a presumption may arise that the Acetous is the condition in which they are united with our Animal fluids. This is in some degree confirmed by the consideration of there being no instance of a proper mixture between fresh Vegetable & Animal matter. In the urinous state no union exists with our Animal fluids, but Acids from Numerous experiments incorporate with almost all our Animalized fluids. An illustration from a single incontestable instance will be sufficient to demonstrate this; the production of a Neutral from the union of Bile

with

with a veg. Acid, from which we might suppose that it is from a mixture of our fluids & acids that a reproduction & regeneration ensues.

I believe that we never, except in morbid cases, discover the least symptⁿ of Acidity, below the opening of the Gall duct into the bowels, & finally, this is all we can say that there is an Acid produced in the Stomach which is blended with this Animal liquor bile & thus forms a neutral which I take to be the matter of Nourishment, hence may we are rather to look for an account of Assimilation on the principles of Chemistry than Mechanism, & that Animal fluid or at least in the human species is a proper mixture of veg. & Animal substances, & that there is always effluvia in the Stomach of healthy people an Acidity. Thus then you see the absurdity of Physicians saying that a quantity of Muriatic Acid Mucus was thrown off by vomiting & looking upon it as a diseased state, whereas in fact it is in every sound Stomach, & therefore its abundance (not merely its presence) can only be looked upon as morbid.

The Animal liquor that absorbs or neutralizes this Acid is the Saliva, Gastric & Pancreatic Juices, Bile & perhaps some other separated in the course of the Alimentary Canal.

I may take this opportunity of giving my opinion on the Theory of physic; a subject which every one is universally dabbling in, for nothing is more common than to hear an old woman talking of the state of the stomach, tho' I may certainly say that we have no more certainty in this part of our Physiology than others which we have thought to be utterly unknown, yet we may be able to get so far as to direct us in our practice & avoid the grosser errors of the more Empiric which many have fallen into for want of an acquaintance with Theory.

This of the Stomach has never yet been carried further than mere solution, diffusion, & trituration, which leaves us as much in the dark about the nature of Assimilation as if nothing at all had been done. I have given you my reasons for concluding with Haubius that this is the effect of a chemical process & not a mechanical.

When I apply the terms Tonick, Acid, & Putrefaction I do not mean them in their exact & common sense they are generally taken in, but a sort of fermentation, the nearest to those kinds of which we have an Idea of, which I rather believe to be of a peculiar kind.

This then I take to be the first great step towards the

formation

formation of our Animal fluids, viz, the mixing our Animal Liquor with a Vegetable matter under proper circumstances, which is greatly supported by the explanation of the Phenomena attending the scurvy from other putrid diseases, for want of Veg. food, where the humours &c. tend towards a putrid dissolution from a want of the Acetous, Veg. salts. The common & ordinary progress of Fermentation is different from what we see take place in our bodies, here is a diff. between the Acetous & putrefactive different from any thing else in nature in consequence of a general mixt.

I shall at present only subjoin a few remarks on the Acid of the stomach, it is evident that the Saliva has a share in abstending the Acid of the stomach, because people who chew tobacco & spit out are more liable to heartburn, acid eructations &c than most others. Weak persons are also liable to a morbid acidity — whence can this arise. How the stomach acts in these cases is difficult to say, perhaps the gastric liquor &c, the cheather of Acidity is only discharged in proportion to the peristaltic motion or action of these Organs, or perhaps, there may be some difference even in the Liquor

secreted

-able lymph is the only part of the blood that coagulates like the albumen ovi, and this being the case there is no part of an Animal body but what we have a proof of this substance existing in. There are some circumstances in Vegetables that do show a coagulation by the powers of heat. There are Vegets that coagulate with Alcohol, so far there is a resemblance between Vegetable & Animal substances, but Vegetables differ in many respects, for as the mucic farinaceous matters, heated to the coagulable point of Farenheit, coagulate, but after that are very difficult of resolution, but if these Vegetables are diffused in cold water & increase the heat gradually till it arrives at the coagulating point no coagulation takes place, but with respect to the lymph & the albumen ovi the case is different as they coagulated equally well with or without water. — As to the few Vegetable substances coagulating with Alcohol they are but few and do not show a perfect coagulation, and as to acids their application is absolutely

ineffectual

ineffectual. When I spoke of the similarity of these two fluids I might have added that the albumen ovi that is so effectual in clarifying vegetable substances by collecting the saccharine parts into one mass is here similar to the coagulable lymph that performs the very same process in the blood — the albumen however is always more bland than the lymph however pure we can obtain it; this is owing to the density for the more anxiously we procure it of this, the more insipid and bland the lymph becomes. The coagulable lymph concretes in cold, and this may give some suspicion of a difference between them, as the albumen does not except in a very intense degree, perhaps this may be owing to its more peculiar diffusion — by cutting the albumen ovi, as in the coagulable lymph, we find a watery liquor exuding from its pores, which exhales by gentle heat, leaving both the fluids perfectly pellucid & so resembling each other as not to be distinguishable; now it is perhaps the water in the albumen ovi that is more inimitable

timately blended with the several parts than in the lymph, and by this means prevents it's coagulation. The parts of the Albumen are more closely united by a delicate cellular texture that may have some effect in the more intimate diffusion of the water. When the Albumen Ovi is well dried & broke down into powder it is diffusible in water heated to the temperature of the human body, but on cooling it separates again, & altho' it has now a greater quantity of water than was sufficient to keep it's parts together before; yet it swims to the surface like the coagulable lymph. The Albumen Ovi is the entire subject of the formation of the Animals in ovo, and from this the nutritious fluid for the support of the Animal germs is produced & from no other source do the diversity of fluids in Animal bodies arise. This Albumen or the coagulable lymph I may call the Nutritious Animal fluid on which all growth of the solids depends. What we said before of the production of Animal fluids particularly applies to this, and therefore all the Acid & gastric liquors together with all the secretions

entering

entering the lacteals apply to the coagulable lymph; there is no doubt of it's being in general produced from vegetables, but we may see how far it differs from vegetables either wholly or in part. That it consists of a certain proportion of vegetable Acid & animal matter perfectly formed. Vegetables evolve a saline matter which neutralizes & in this case the saline matter is more involved than before; it seems a curious circumstance to consider that the Acid from crude vegetables is quickly evolved in the stomach & intestines immediately, tho' by art we cannot extract it without a considerable degree of heat. Some have endeavoured to shew fermentation takes place without the evolution of an Acid as they allege is the case in Animal broth without vegetables, which exhibits a fermentation without any Acid evolved. I tried the Lapse but it did not succeed with me, yet from other circumstances I am inclined to admit the fact. So far we perceive a difference between the Animal fluids & the vegetables of which they are formed. It is not a putrid matter or even going on to putrescency

putrescency as has been imagined, it was tho't that the Animal fluids like thrown out of the body were going on in the regular stages of fermentation, but this is improbable from our fluids not shewing the least signs of putrescence. We know of no stage of fermentation analogous to this that takes place in the body, and it is formed partly by fermentation and partly by mixture, & seems in some degree of stationary. It is not putrescent because in no Experiment it discovers Air evolved, & in every stage of fermentation we know of we discover no saline matters evolved, therefore this seems to be some intermediate process tho' a more stationary one than any of the ordinary stages of fermentation, exposed however to such causes as produce changes in it, tho' it is not putrescent yet it is a matter prone to putrefaction. From the general Phaenomena of the Animal Oeconomy our fluids are constantly changing into matters that would be poisonous to the System, unless on the commencement of this change they were thrown out of the body, and in most part of their progress we can

observe

observes a tendency to putrefaction. We see in the human body saline substances are evolved which give Acrimony in the state of Neutralization, exhibiting an Ammoniacal salt by a spontaneous exhalation — by saline substances evolved & fermenting, the coagulable lymph loses the power of Cohesion; this is so manifestly accompanied with so many marks of a saline nature like they degenerate into that state and the lymph in consequence of this becomes more & more soluble in water, and this degenerated part of the saline Animal fluid & the coagulable lymph joined with the watery part of our fluids forms the 3d part of the blood, the serosity which we know to be water impregnated with saline matter. — If we consider the resemblance between the serosity & the secretious part of our fluids, the Urine, we shall then consider it as an effect of the degenerated state we speak of in the progress of our fluids. Vegetables give the proper animal fluids the lymph that by the motions of the system proceeds to a degenerated state, which degenerated part uniting with the

water

water forms the density which is constantly thrown out of the body. We cannot absolutely determine whether the density as it is in the vessels is precisely the same as the Urine, tho' some have considered them as such, which presumption must lead us to consider the nature of

Urine.

In Urine we find a variety of saline matters whether it is an excrementitious fluid or part of the Animal fluids degenerated & thrown out of the system is uncertain. It is but lately that Urine has been examined with any degree of accuracy, & the experiment has not been far enough pushed as yet to ascertain the nature of it's salts with exactness. There is one species of salt that we can positively fix on a calcareous salt united with nitre, matter, and the fixed vegetal is changed into a volatile one in toto Animal is changed into a volatile one in toto Animal or animonical salt, and we find this salt to be produced both in the Urine & the density from whence the Urine is formed. Whether this salt is confined to the Animal body may be

Or

a question, it only appears where vegetables have approached to a state of putrescence. We find an Ammoniacal salt in the Urine formed of a volatile Alkali & a peculiar Acid, this is now well known to be the Acid of Urine & I think is also the Acid of Phosphorus. Margraaf has made many Experiments on it, but has not ascertained its production or effects in the System, whether it is necessary in the Oeconomy or happens only in consequence of a degeneracy of the fluids, I apprehend it is not entirely excrementitious, and perhaps the purpose it serves in the Animal Oeconomy is to keep the fluids that is the coagulable lymph in a dissolved state in the heat of the human body and the density seems to be necessary in preserving the proper tenuity of the fluids & consequently keeping up the proper diffusion. I am disposed to add another suspicion that the density is itself a progress towards putrefaction, but it being the means of preserving the diffusion.

This is all I have to say as to the properties of the

the parts of the blood. The proportion of their parts is a difficult problem that has been too rashly attempted. The proportion has been taken from the fallacious appearance of spontaneous separation. Physiologists have determined the cruor to be in one proportion the serum in another, but the separation is so liable to be affected by a variety of circumstances that the real proportion between the different parts cannot be exactly ascertained. Haller is not yet acquainted with the fibrous membrane being composed of red globules & lymph, & hence speaks of the proportions as entirely common to the whole mass of fibrous membrane, hence he speaks of the cruor being often equal to half of the mass of blood, and in very robust Animals he says the serum is only one third of the mass. The red globules however from many considerations appear to be the smallest part of the mass & a very small number of them will give a florid colour to the whole — The red globules when separated to a certain degree & quite single are perfectly colourless & transparent &c (Emac observes, and hence perhaps there may be colourless

colourless globules in the serum. It is a difficult & inexplicable problem how the red globules are produced from the different states of the Aliment. As they are intended to support the fullness of the vessels & to serve as a resistance or counterpoise to their action they will be in proportion to the rigidity of the Arterial fibre. As they serve to keep the whole mass in a diffused state there will be a due proportion kept between the constituent parts of the blood without the assimilation of any increased quantity of the coagulable lymph, whose larger proportion makes a considerable part of the Animal fluids, the production of this is the purpose intended by the taking in of Aliment, and its increase will be in proportion to the quantity & quality of the Aliment, & of the assimilating powers of the System. It would be worth while to enter into a consideration of the causes that may diminish the quantity of lymph, the powers of putrefaction taking place would render it more soluble by increasing the dissolving power of the Serum. With regard to the proportion of the Serosity it will be nearly as the liquidity of the Aliment taken, this however must

must be under some limitations, yet it has a consiederable influence on the proportions. The density has a greater tendency to Putrefaction than the other parts disposes them to that state, of which we can make a tolerable Judgement from the state of the Excrementitious fluids of their Saline parts. The quantity of the Serosity is greater than we commonly apprehend, for altho' the Serum is formed into a perfect Coagulum by which we comprehend the quantity of watery liquor to be very small, but this circumstance is extremely false, for a small quantity of solid matter may entangle a very large proportion of fluid, so that the liquid parts shall seem to disappear, which is evident from the consistence that the Albumen ovi will give to a considerable proportion of fluid, or let us to a still more remarkable instance of Salep, a tea spoonfull of which will give consistence to a pound of water, and for any thing we know to the contrary the Animal fluids may still have greater powers of coagulating fluids, and by entangling

them

them within the pores they seem to appear in a very diminished proportion.

What other matters there are in the mass is another important question. It is alledged, first, that the chyle subsists constantly in the blood while we regularly take aliment, but the evidences of the formal appearance of this are much to be doubted. Many of the experts in order to ascertain this are made before the separation of the coagulable lymph was known, they might therefore be mistaken in this, and together with the Arguments for diffusion give additional grounds to believe the facts alledged on this occasion were erroneous, & give rise to the production of Pus might lead into some false conclusions - Yet we may believe the chyle is never perfectly assimilated in its first passage thro' the Lungs, because milk seems to differ in almost nothing from chyle, but there from the small quantity of it at any time mixed with the mass the great agitation & diffusion would probably cover it so as never to let it appear separate except by secretion. A portion of the chyle therefore not quite assimilated keeps constantly

constantly present in the blood. As we have supposed this, so may we on the other hand that a portion of our fluids degenerated are likewise constantly in the System ready to be evacuated, hence we may say that our mass of blood consists of 5 parts.

1. Aliment not quite assimilated.
2. Perfectly assimilated Albumen.
3. Degenerated Albumen.
4. Albumen converted to Serum.
5. Red Globules.

Are there no other matters but those we have enumerated. Dr Senac speaks of two other parts, the one he calls Jelly the other Mucus. The Gelatinous part does not appear from any observation yet made, the Jelly he hints at is that which we get by boiling Animal substances, no Experiments however shew its existence in our Mass of blood. Imagine it has been supposed by Senac from Theory, that this was the foundation of our Solids, therefore existed previously in the blood; this Jelly is not a Solution, but I chuse to call it Extraction, for every new extraction from the same matter

gives

gives a different product, which shews it is the decomposition of a mixt, & not the solution of an Aggregate, hence there is an evidence of its formal existence in the Solids and fluids. As to Mucosity we shall perceive there is some foundation for thinking it among the parts of the blood if we consider the viscidity of Serum, the copious secretions of mucus every where in the System which are exposed to absorption, but no Expt determines the existence of Pus in the blood, but it is different from Lymph in not being coagulable, but still it has such a similarity as to make us suppose it derived from Lymph, yet we must be careful not to admit it but by Experiment as we know that the Secretions do not shew a formal existence in the Mass of blood, i.e. that there are parts in the blood fitted to undergo certain alterations so as to be converted into a secretion but the fluids in the excretories are in this manner changed & must have existed in the blood in a crude unmodified state. ——

D.r Haller draws an Argument from the quantity of Mucus taken in, but there is no reason for supposing that this is not like our Aliment assimilated. Hence says he if you take a fresh Animal Stomach you may successively scrape off a great quantity of Mucus which he thinks could not probably be contained in the Mucous follicles of the Stomach: but the capacity of these is not determined, but they appear from many considerations to be considerable; he might also have been mistaken in a watery fluid furnished and terminated with Mucus, besides the secretion of Mucus seems to be made in an extremely fluid form so that certainly it must remain in follicles to acquire the consistence & hardness in which state he found it which cannot be found, in which state he found it secreted. The Experiment therefore does not demonstrate or even render any way probable the existence of the Mucus in our Mass of Blood. Many have thought there was an Acid perfectly existing in our Mass of blood, we know that it is secreted into the Cellular substance & often absorbed from thence very suddenly

dently, and the great quantity taken in with the similarity between Animal & vegetables Oil would give a presumption that it was in the mass, but no Experiment actually shews this; I never saw any thing like it, nor do I think it is formally present in the mass; I have sometimes seen a globule or two floating in the serum & coagulable lymph like Oil, but this did not occur once in two hundred, even then it was not easy to prove it to be Oil. There certainly are a variety of smaller present accidentally in our blood, many saline bodies which when present are constantly joined with the Serosity. This Serosity does evidently perhaps several saline matters that we have not ascertained them by Chemical Experiments.

We next enquire how far Air is in our fluids: it seems to consist in the formation of most bodies in Nature; it has indeed been doubted whether Air is formally present or only generated in consequence of the Experiment by which it is extracted — in our fluids it is evidently present — we know it only as being Elastic, that certainly

it is in bodies in a fixed state, as it is called – this is so changed from its ordinary known properties that we cannot say what are its effects in the constitution of bodies, but are certain its properties are changed. We must enquire whether Air is present in our fluids in an elastic or an intermediate state, when it is seemingly fixed, but easily brought to its elastic state. In this view we find Air copiously contained in our Animal fluids; many morbid phenomena lead us to think that sometimes it is even perfectly elastic, and it always perhaps is in our fluids in the half elastic state as we mentioned, for by taking off the pressure of the Atmosphere the Air becomes elastic & escapes copiously, this is so in our Animal fluids; this Air is likewise easily extricated by the first beginnings of Putrefaction, the sources of this Air may be understood for it is in the same condition with much of our Aliment – in Mandication a quantity of Atmospheric Air is entangled in the inside parts of our food & thus gets into the Stomach

along

along with our Aliment. The sources of it then here are, 1. The Atmospheric Air entangled. 2. The natural Air of the Aliment, & 3d the Air generated by fermentation. It enters the Lacteals with the chyle as appears from Experts In the common mass of blood this greatly disappears without our knowing where it has its issue; whether it is expelled by the Lungs or absorbed by certain powers is uncertain, tho' being less copious in the blood than chyle is undoubted. Another fact is that in some of the secreted fluids the Air is more difficultly extricated than in the blood, and is not only much less elastic but much less in quantity, when you subject them to the exhausted receiver of an Air pump you see bubbles emerge at the surface, but the Air is not sufficiently elastic to break them; it is difficult to apply either hypothesis formerly mentioned, for in many secreted fluids there is a greater quantity of Air readily extricated, than in milk for instance; this will be readily explained by those who suppose the milk immediately secreted from chyle, but this will not apply to the bile which affords Air very copiously and also saliva.

What

What conclusion to draw from these facts I cannot determine; it was in the formation of the fluids are not known, that it certainly seems to have some share. We have spoken only of Atmospheric Air; but there is another. Nitrific Air, that the Serpentine are so few as not to determine the particular pre- sence of either. In our cellular substance there is always a passage for Air, as appears by the practice of Butcher's from the appearances in Emphysema. Certain Anatomists have discovered two distinct portions of cellular substance, one fitted for Air, the other fluids, another adapted like the lungs, for Air only. Senac affirms there is such a cellular texture in every Membrane of the body, and that by tearing them you may discover really the presence of Air; this fact is so far carried as to lead to suppose Air continually secreted into those Membranes, or that there are causes in ordinary health that tend to evolve Air, therefore in morbid cases this may further take place, hence Emphysemata may happen from external causes. I have seen Emphysemata very general without any obvious way of external Air being introduced, this therefore

may

may lead us perhaps to morbid considerations not yet suspected.

This finishes our account of the morbid mass of blood; we must consider that all other fluids are properly from this, that this is the basis of all our fluids diversified, for which there is a particular apparatus which must be considered. This step then leads us to

Secretion.

This function is not more important than obscure. I agree with Haller in his introduction, he especially in that part where he insists on the good that may arise from Physiological Hypotheses. Considering how many fluids are produced different from the blood we shall see that secretion is one of the most important functions in the Oeconomy, & I am sorry to add, what we know least about. I would recommend Haller's introduction to this subject which will like wise apply to other parts of our Physiology. —

The term secretion merely signifies the separation of parts of heterogeneous bodies in the way of mechanical Straineries; we must however admit that there are new mixts formed by this function, and then the term will not apply. The first question is whether

the

the secreted fluids, as they are called, exist in the blood
mass, and are only separated by secretion as com
mon straining, or whether they are formed by che-
mical decalition or decomposition. Milk of cheese
is an instance of simple separation; many of them
there certainly can be no doubt about, that some
of the secreted fluids do exist in the blood then
capillaries secretion from arteries on the surfaces &
on all the cavities of the body, which appears to
be exactly the serum of the blood, this is a simple
exhalation & requires nothing but a different
size of aperture in vessels which pour out fluids
as they are filled to force thro' their descenders, this
in some degree takes place, for the fluids after se-
paration finally nearly resemble those in the mass.
from many other perspiration & mucus resemble
the density of the blood, & these are separated per-
haps on the simple footing of secretion; thus the se-
paration of serum may be explained by vessels
not admitting red globules & perosity by vessels not
admitting lymph, further than these perhaps we
cannot find that secreted fluids are present in the
mass of blood, this mucus we have shewn is not
formally

formally present, yet it appears not very dissimilar to Serum, and Saliva is found not to differ much from Mucus, yet these differences create as great difficulty as their complete formation from the common Mass, the Bile is not even suspected to be ordinarily present; one Argument is that we never see it except in cases of morbid absorption; the Colchicum Serum, the Semen, & others cannot be supposed present. Another opinion has been that these fluids were not present in the blood but formed by certain mixtures taking place in the vessels of Glands, as they supposed the Bile to be at first formed by the union of an oil & the Alkali absorbed from the intestines & carried to the Pancreas, but we have proved that Oil is not formally present in the Mass & therefore is likely to be accounted for, and this hypothesis is therefore incompatible with our present Chemistry. The doctrine of Secretion is embarrassed by our not being able to judge of the proper mixtures of Elements or the fluids formed from them; therefore with regard to most part of the secreted fluids we cannot even say that there are matters present in the

(blood

blood from which we can account for the formation.
We must then examine the supposition of chemical
resolution & combination; the secretory apparatus
have chiefly the same effect. Different hypotheses
have been formed; one is the different velocity
of the blood in different Organs, from their distance
from the heart, from flexures & angles of the ves-
sels; thus they also proceed on the supposition of
the formal existence in the mass, to whose use must
fall, but independant of this their reasonings
are not sound. Formerly said if a vessel broke
fast in one might see there might happen a se-
paration of heterogeneous parts, then the light
parts would fly off, the heavy keep more to the
axis of the Canal; but this does not take place,
the vessels are continually ramifying & thus of
consequence become flexuous, the heavy parts
will impinge on the sides of flexuous parts &
thereby give a very perfect difference. But in
fact the different gravity of the parts of the blood
is so inconsiderable with regard to their vast
division as would render this variation of mo-
tion (with regard to the heavy parts keeping the

axis

Axis of the Canal is inconsiderable, thus Gold may be divided so as to swim in water — nor is there in any case as far as we know any particular preparation of the blood, hence the changes seem entirely to depend on a secretory Organ.

Haller supposes the fluids previously existing in the blood, and to make this more plausible he divides them into classes.

1. Coagulable fluids, thus the fluids exhaling into Cavities, as the Succus Gastricus, &c

2. Watery fluids which he divides into such as exhale & such as are deposited in receptacles.

3. Mucus. There is but one general species of this poured out wherever Air or Acrid Matters pass, hence he adds a fluid, the Semen, for wch there is no foundation for a resemblance with Mucus.

4. Oily fluids.

This Scheme is not altogether wrong, but I would add that the general division of our fluids may be into Oily and Watery.

I. Watery — subdivided into

A. Mucus.

B. Saliva & pancreatic Juice

C. such

C. Such as are of more fluid secretion, as Urine & Perspiration.

II. Bile.— Every thing here is more doubtful— they are not so much a species as a combination of Oil with some of the watery parts. Even in the first class I have found a resemblance between saliva & semen, yet here is such a difference as makes us infer a considerable operation to the secretory Organ. An argument on this subject is that in the Ischuria renum, the Urine is stopped out of almost every part of the body, this shews that Urine exists previous to its passage from the secretory. As to bile, Jaundice arises when the secretion is stopped; there is not a fact in Physic of Bile's arising more abundant in blood, there are then fluids certainly formed in the secretory itself. There is something very analogous in plants, they afford a great diversity of fluids; were these fluids absorbed perfect from the Earth? Such a supposition was formerly made that the Earth contained the particular Juices of each plant. Physicians now agree that there is a common matter of their nourishment which will serve for a thousand different plants

plants, but in vegetables there are particular confined
secretions independent of the common master taken
by the roots, thus a flower different in calyx petales
seeds &c. Anthera is often seen, there must be there
a secretory power in each of these particular parts.

This brings me to the importance of the secre-
tory apparatus. The first order of Sheaves & angles,
there have been supposed to diminish the velocity
of the blood in such a manner as to produce a
separation of parts, but if these are proved not to
exist previously the hypothesis must fall, besides
the effect of the sheaves is such as rather to give a
more perfect diffusion. The Apertures of the vessels
certainly have some effect, these may be varied
by the Impetus of the blood & their being more or
less in a relaxed state. If then the velocity was not
diminished the simple secretion of serum would
not take place, as we find that in the case of a
too great impetus error loci frequently occurs. The
diminution then of the velocity gives a more ele-
gant secretion of the parts of the blood, the organs
of secretion then have a great effect, but here the
difficulty begins. About the beginning of this century
the latter end of the former Physiologists were divided
concerning

concerning the Ruysheian & Malpighian systems of Glands — the latter supposed the glands a congeries of follicles — the former that they are composed of a decreasing series of vessels. It is compromised now that follicles are interposed between the secerning and secreting organs in many cases. The Malpighian structure in some degree is then to be admitted, but there are many secretions & excretions performed without the intervention of follicles, these are composed of a series of decreasing vessels, the arteries divide very minutely & the secretory vessels pour out their fluids, or unloving again may rise in an increased series before secretories, this is the Ruysheian structure — Even upon the Malpighian doctrine we must in every case almost admit the Ruysheian system, for I know not an instance of a fluid poured into follicles without having undergone some change in a series of decreasing vessels — what effect these decreasing vessels have we are at a loss to say — The difference of aperture is the first that occurs, this may have some effect in separating the parts of a heterogeneous aggregate, but how these should give a difference of taste, consistence and other properties we cannot conceive —

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It is certain however that difference of Aperture has an effect, thus secretions are different in the fœtus & the adult — To avoid this difficulty they have said the fluids here were the same, but this is contradicted by Experiment in the fœtus & adult. The Excretory vessels are liable to spasmodic affections; it is well known that most of our secretions are affected by disorders of the Nervous System which we cannot suppose to act any way but by contraction & relaxation. The Urine has ordinarily oily saline & earthy matters, giving it odour, taste & colour, if upon an affection of the Mind these properties should disappear we must suppose a spasmodic affection of the kidneys — when gross matters come out we cannot well say this is owing to an oppo-site state, viz, Atonia, or to increased impetus — increased impetus however in many cases certainly alters secretion, & we cannot suppose it acts in any other manner than by varying the Aperture. In Anatomical Injections nothing is more common than for the fluid part to pass into vessels wch do not admit coloured parts, tho' this may be done by increasing the force of the injection, here there is evidently

evidently a secretion depending on increased impetus and a different size of aperture). All these apply well to the hypothesis of the previous existence of the fluids in the mass, & nothing more was required on the supposition of all the secretions formally existing there than a separation of these ones from the other which office was done by the glands, the the structure or secerning organs. But if we take the other supposition of a chemical alteration in the nature of the fluids & not merely a separation taking place of new products by the glandular apparatus being made from fluids perhaps entirely dissimilar in properties, if we take up this notion we must endeavour to find out a more applicable hypothesis. Mr Winslow supposes that at the first formation of Animals the secretories are imbued with certain fluids that only admitted such as were like themselves, analogous to the circumstance of paper oiled which will not admit water, & vice versa; this is specious — but we may object that any secretion may be poured out by almost any other secretory or vessels thus bile frequently passes by the Kidneys — again in an Ischuria renalis

renalis the Urine comes out at every outlet, but of this if requisite we could produce a variety of instances. Another hypothesis is that the fluids are moved by a capillary attraction & that the matter of a certain density has a natural affinity with fluids of the same density, hence the fluids would associate with the organs of their own density nearly, but there is no such diversity in the density of our vessels & the passage of secreted fluids by other secretaries than their own sufficiently excludes this hypothesis. As the Doctrine of a decreasing series will not explain the effects of changes of mixture that takes place here must then be some power of mixture & fermentation that helps to form our fluids. Physiologists have supposed here that vessels secreting certain parts may again Anastomose & unite their parts in different proportion, but the existence of these is very doubtful. have never yet been ascertained by Anatomists. But if fermentation is necessary to secretion this can never be supposed to take place in a decreasing series of vessels, & therefore they have so far adopted the system of Malpighi by saying that the secerning vessels poured out a fluid into certain follicles where it underwent a fermentation in consequence of

&c.

its stagnation. This opinion is founded on Anatomical observation whereby a minute injection we observe the follicular structure, being little bags distinct from each other, having no vascular continuity, which the advocates for the Brunonian hypothesis interpret to be a particular disposition of vessels in the glands sometimes rolled up in various convolutions, at other times less tortuous like a [illegible] brush, which causes the deception of the follicles, for when the vessels are unravelled, such the minuteness of them renders impossible they appear to be merely vascular; but upon the supposition of a morbid state the following powers may take stagnation in the follicles these powers may take place, viz.

1. Mixture.
2. Fermentation.
3. Absorption.

1. Mixture. Somewhat we mentioned may take place more perfectly, several fluids may be poured in different proportions & thereby give different properties.

2. Fermentation. This has been excluded, but it must be allowed in most cases to take place; the progress of the Chylopoesis shews them in the morbid states of the body; it has been said that this is formed by a particular

fermentation

secretion & this is perhaps is true). From Gaberis Experts we know pretty certainly that Pus is formed of the ordinary Serum & varies as the Serum varies in its contents. The formation of the Pus depends evidently on a certain progress in fermentation; it further is perfected by Exhalation or Absorption.

3. Absorption. It may operate by abstracting the thinner parts; this may have two effects.

1. If the thinner fluid is Acrid it will leave the thicker more mild, this takes place in Mucus.

2. If the thicker is more Acrid the Absorption by taking off the thinner will leave the Secretion more Acrid, this takes place in the Bile.

(We have now discussed the doctrine of Secretion as far as our knowledge of the subject will admit of; this is one of the most important at same time the least known of any function of the body. I mentd a variety of opinions all of which have their Objections, even that of follicular stagnation & being subjected to a fermentative process meets with many difficulties, for there is no room for stagnation & consequently none for fermentation where the fluids are perpetually hurried on by such a rapid motion. There may be a secretion on the surface of parts merely united

united by diffusion, for we have nothing in nature analogous to this different size of aperture in forming a new mixt; if we assume the notion of secretion being merely separation then this may have some effect, if not we must return to that very difficult problem how a decomposition is produced. Supposing the mass of blood to be an heterogeneous aggregate we may suppose by a different size of apertures a separation may be performed thence a new mixt produced. I shall illustrate the whole of this by an example at the apex of morbid secretion, it occurs however readily in our system — I allude to the production of Pus, this is a fluid not existing in its proper form in the mass of blood, it is the production of new fluids, we find it depends on a state of the series of decreasing vessels but never produced but when they are under peculiar circumstances, when the vessels are in an inflamed state, here then we have a state of a series of vessels occurring in every part of our system, these separate from the blood a peculiar fluid, whether this fluid undergoes any peculiar change in passing thro' these vessels is uncertain, for the pus produced is in consequence of a subsequent fermentation which changes the fluids in the

the before mentioned from Gaber's hopes that (this was
produced from the ordinary serum of the blood wch
in order to effect that change must undergo a fer-
mentative process, for it is not previously existing
in the mass, only a change brought about upon
the fluids of the mass that disposes them to a fer-
mentation. This gives a more complicated view
of the different parts of secretion, I now add a
particular with regard to the power of the secre-
tory Organs, this power appears not only (from
reasons given) to produce the ordinary change
upon our fluids, but also in varying these con-
siderably as we find several of them consider-
ably diversified which must be owing to some
peculiar circumstances in the present state
of the Organ. as in stimuli applied to secretory
ducts & perhaps to the secretory vessels, produce
considerable changes in the properties of the
secretions. It has been thought that irritability
was merely confined to the secretory ducts.
In suction of a child at the breast where the
excretories are emptied we find the secretion
increased in a greater proportion as the charge-
ness of the evacuation requires; but from this
proves

there is a change in the quantity & quality of the fluid & this must proceed evidently from the secretion being too quickly urged on; this takes place in perhaps all our secretions & is a proof of their irritability, i.e. of the secretory tubes (because) any increased motion must imply the application of a stimulus — other powers acting on the Nervous system can produce an alteration in the state of every secretion in the body; the instances of the passions of the Mind affecting the common Origin are sufficiently obvious, & some of these are more disposed to act on one secretion than another & producing morbid changes in the different fluids. Anger operates on the secretion of Bile, & Fear operates on the Alimentary Canal. We know many other affections of the Mind have a considerable influence on the several secretions of the body, it must act on the secretory tubes in consequence of their having a Muscular coat & it's fibres being put into states of relaxation & contraction by their action produces a change on the condition of the fluids. We shall find this to be of considerable influence in our Pathology [illegible]

[illegible]

Physicians have been hitherto too rash in inferr-
-ing the state of the blood in the common mass,
from it's state in the secretories for the secreted
fluid independant of it's modification as a secre-
-tion is liable to be influenced by the various,
causes above mentioned, whose effects are in
a manner topical without any affection of the
common mass. There is no doubt but an affec-
-tion of the common mass may affect a change
in the secretion, but this is by no means univer-
-sal, for they are merely owing to changes in the
secretory organ itself; therefore tho' we can the-
-roughly ascertain particulars we can by no means
admit of general conclusions, thus in Gouty
people when the chalky matter is thrown out
on the joints I cannot affirm that this matter
previously existed in the mass, the blood may
remain as before & concretions may be gene-
-rated by the state of the vessels. This finishes
the distribution of the blood in Animals united
into two general purposes, 1, and that we have
been considering is secretion; the other, still
more important, is especially for the production
of matter necessary to give growth and nutrit-

to the body: This is what we call Nutrition which respect the supplying the fluids and solids. —

Nutrition.

Under this head I comprehend every part of the Animal Oeconomy relative to the support of the body. I previously observed that this might be considered as a branch of the former subject of Secretion, but I prefer it to a separate Article, with a view of treating it in a way more general & comprehensive. The subject naturally divides itself into two kinds —

I. The support of the fluids.

II. The solid matter giving the substance & form to the whole.

The first evidently depends on the Aliments taken in & assimilated to our fluids & therefore relates to functions we have already considered. Hitherto we have touched chiefly on the preparation of fluids as to their qualities; there are some questions concerning the [illegible]

& Excreta, and others which remain to be considered; that we shall hereafter invert in our Pathology. Our present object is

The Support of the Solids.

Our solid matter is certainly derived from the fluids & hence this function (respecting its immediate formation) depends much on the former. Hitherto we have considered the fluids as forming one common Mass, and as performing the different Secretions. Our view at present is to consider what portions of the fluids are distinct for the supply of the solid matter, the manner of its separation & application to the Solids in their proper places, and further the means by which it is fitted from its fluidity to assume a solid form, under the Arrangement we observe to take places in the Animal body. These questions will appear to admit of two divisions

I. The Extension or growth of solid matter in every dimension.

The Animal body, originally of an imperceptible bulk, constantly encreases for a certain period till it arrives at a considerable size. To this rapid exten-

sion

vion Nature has set her limits, & fills no further
accretion occurs but such as may contribute to
give a greater density to the parts already formed.

II. Now after the complete formation of the parts,
the Animal body is exposed to the alternate vicis-
situdes of waste & repair.

From the time that Vitality is infused into the
germ, like the System has progressively arrived
to its complete dimensions, we are to consider
the matter as applied to the increase of the bulk.
Different from this may be the reparation of
waste which only occurs when the size of the
body is completed.

I shall begin with the first. The minuteness of
Animals at their first formation, & the mode of
application & preservation of the new additional
matters for the increment of the whole.

You will observe that this question is intri-
mately connected with another relative to the
formation of bodies, Animal as well as Vege-
table, the prosecution of which must necessarily
involve us in the business of Generation, a ques-
tion long agitated and hitherto remains an in-
explicable mystery. I have never been fond of

questions

questions that had the remotest tendency to elucidate a subject in view, this however curious is of no sensible utility, being for the most part inapplicable in our system of Physic. From our want of insight into the Oeconomy of Nature these subjects are necessarily involved in obscurity & confusion, such therefore we reject & avoid a clue that would lead us to such a labyrinth of uncertainty.

It is necessary for us to state the question more generally & state deliver the two prevailing opinions concerning it.

I. That Organized bodies descend on certain Germs or Stamina first formed by the Creator; that these from a small bulk originally, receive all their subsequent increase, by Evolution, by the extension of parts already formed & delineated, that merely in consequence of this further extension, do they assume their after complicated form.

II. That such Stamina are no where existent in nature, but there is a power in every Animal of producing such Stamina with other matter determining it to a certain form, and that all this matter is first begun in a former Animal, on such a

supposition

* Traité des corps Organisés.

supposition most part of the completed organization must have been begun and conducted in the Mother, that while the matter exists there are peculiar powers in the mother to modify the Germe or Embryo. Or for a shorter form of these questions,

Whether or not is every part of the Organization delineated in these Stamina, and that the after growth depends entirely on Evolution? Brim the Stamina only of so many parts as may determine the after organic Accretion or Epigenesis? I were disposed to assume the first supposition and adopt the notion of Original Stamina, for this reason that the growth of Animal bodies so far as they come under our inspection evidently depend on parts already formed or delineated, the extension or evolution of the parts being the sole means of the subsequent Accretion. For a further view of this subject I refer you to M. Bonnet of Geneva*, and to Dr Haller in his Elementa Physiologiæ; the opinion of the latter is much to be regarded as formerly he was out on the other supposition.

The Doctrines of Evolution & Epigenesis may both be admitted, which in some measure conciliates those different opinions; thus it is supposed that

that the ultimate Ramifications of the Arteries are formed in the Stamina, which tho' not permeable to fluids in the state of germs, yet are afterwards in the progress of vitality opened by impelling fluids in consequence of a more perfect Evolution. But there are other parts that are not vascular to which there is no reason for supposing pre-existent in the Stamina of original germs. A matter, for instance, is perspirable, which forms the hairs, that is allowed to be an organic concealment & is merely the effect of Evolution, but perhaps we may consider the skin & other parts as not pre-existent in the Stamina, when an Hypothesis so far hastens with Evolution.

In whatever view we consider the subject it will be impossible for us to conceive the formation of the Animal body without the supposition of original Stamina formed by a superior power. I shall confine myself to the following Questions.

I. What is the proper Nutritious fluid?

II. What portion of the fluids in the Animal body seem more especially to give the Nutritious fluid?

III. Whether this is a fluid every where present in the System of vessels, ready to be applied to the solids

solids? or

IV. Whether it is generally diffused in our fluids & requires to be separated from the heterogeneous mass previous to its application?

V. By what means when separation has taken place, is it conveyed every where to the ultimate fibres of the system of solids?

VI. What are the circumstances of its application, or how do these ultimate fibres become extended by the fluid, which must likewise be converted into solid? — Or a better form of question is

(By what means, when they are conveyed, the fluid is converted into the Nature of the solid fibre, as to encrease its extension & solidity?)

As a subject so enveloped with difficulties as the present I cannot expect to demonstrate these several questions with any degree of certainty. In a path so intricate & obscure it will be sufficient if I arrive at some degree of probability.

As to the first question I have already alledged the Nutritious fluid to be the Coagulable lymph, either in the condition we find it in the common Mass of blood, or as furnished by proper secretions, probably this is the chief substance produced from Aliment

Aliment taken in, it is the principal Animal fluid, and the intermediate state between acid or Acescent Vegetables & putrid Animal substances, & from it's being the object of Chylification & Sanguification it must certainly be destined for the support of the more permanent parts, the Solids. It bears a perfect resemblance to the Albumen ovi, the Nutriment of Oviparous Animals, & from whence they draw the Accretion of the Solid & fluid parts, the consumption of which fluid is proportional to the growth & increase of the Animal, whence from a similarity of properties we transfer the Analogy to their Mutual Utility, each from it's nature adapted to the purposes of Nutrition, & the Albumen being manifestly Nutrient, the conclusion from the sameness of property to the sameness of function, seems inevitable.

The chief difference that occurs with respect to these fluids, is, that in order to the application of the Coagulable lymph for the purposes of Nutrition a separation from Saline matters must

must take place as we don't know that in any Viviparous System we can find the coagulable lymph distinct and separate from the other parts of the Mass, being constantly combined with a saline fluid, the Serosity.

Objections have been made to the similarity of the Albumen and coagulable lymph; that the former does not coagulate when exposed to the Atmosphere; but every other Examination shews that they are even materially the same. This difference seems to be owing to some more intimate mixture of a different fluid between the particles of the Albumen, a fluid that from every trial appears to be a most perfectly mixed water. We never have this power in the coagulable lymph as it necessarily entangles a portion of the Acrid Serosity. The Albumen then probably undergoes some preparation which we must suppose is perfected by a Secretion. Such a process is equally necessary for the fluid in Viviparous as in Oviparous Animals, the lymph being inadequate to the purposes of Nutrition till previously purified by a Secretion

If then (coagulable) lymph is the matter from which the Nutritious fluid is formed, a particular organ must be appropriated for the offices of secretion. Contrary to this doctrine is the opinion of Boerhaave & his followers who assert that this change is performed in every part of the System, in every Arterial extremity.

(Boerhaave) supposed that every evanescent Artery poured out a fluid for secretion, & from his notion of the construction of these, viz. their continuity with the Nervous Extremities, concluded the Nerves were the Organs of Nutrition. He supported this opinion of the Brain being a secretory, by not allowing this office to the Arteries, tho' it is improbable that a particular Organ should be assigned for that function be in common to the whole Arterial System.

The differences between the Alb: Pui & coagulable lymph we before mentioned were owing to the more perfect separation of the former from Saline matters, & it is rendered probable from the Acid sensibly being present in the circulation that Nutrition is not carried on in the larger Vessels.

Having proved from the Analogy of the Animal

Oil

Ori to coagulable lymph that the latter is the nutritious fluid in transparent Animals, we proceed to enquire by what vessels this fluid is distributed & applied to the different parts of the solids, whether it is conveyed & supplied by Arteries or Nerves. Dr Hunter & some other eminent Physiologists have assumed the opinion in favour of the Arterial system, but experience does not decidedly attending the admission. It renders two suppositions necessary, either that the nutritious fluid is in the vessels in which it flows, immediately applied to the sides of those, to increase their extension, in which case if it is applied to the simplest vessels it is conceivable and conducive to the end, but if it is applied to parts of a more complicated structure, to the layers of fibres of the cellular texture, it is not only necessary to suppose that it is immediately applied to the innermost but that it must by applied to the innermost but that it must by transude thro' the sides of the vessels to penetrate the external surrounding matter.

If we admit of the Boerhaavian structure that every vessel is formed of a Membrane wch is composed of an interlexture of extremely minute

Vessels

Vessels, i.e. the true basis of this system. I say he admitted their mode of nutrition is more conceivable but less difficult of application. — But more accurate Anatomists have exploded this notion of their structure, and if you admit the body to be mostly composed of cellular texture then on the application of Nutriment to the larger vessels there must be an exuda-tion thro' their substance for the fluid to be in contact with those parts adjoining to the vessels.

This Supposition is indeed maintained by no body, but they are reduced to the effect, that if the Nutri-tious fluid is conveyed by Arteries it must be distributed by the smaller Arteries (the minimæ vasculæ) to every point of the system. They say that the increase of the body consists in the growth of the cellular texture, which owes its formation to the effusion of fluids every where poured out by the Arteries, & encroaching, but their fundamen-tal supposition is erroneous, for it is the fibrous staminal part of the system that is first formed, from which the cellular texture derives its formation; how the Arteries are formed from the

the cellular texture is not so obvious, we must have recourse to the nutritious fluid supplied in every part of the cellular texture, it is present in every part of the blood, but being intimately mixed with the serosity it must be prepared by the secretories in order for its application to the solids. There is no proof of any such secretion being made by the arteries, and we know that the fluids they secrete are by no means mixed intimately, the chyle & saliva are in no condition to be applied to the nutritious purposes, hence the general supposition that Nutrition is performed by a fluid distributed by the arteries is in many respects unfortunate.

Another more probable supposition & more applicable to the Phenomena is that the Nutritious matter is distributed & applied by the nerves, & that these consequently are the organs of nutrition. To maintain this position it will be necessary to produce all the proofs in our power.

The first Argument I shall adduce is from Boerhaave, founded on the glandular apparatus being placed in the cortical part of the Brain & in some

part

long an opinion that the nutritious fluid was supplied by the nervous canals, that the brain was the secretory organ preparing the fluid for the secretories the nerves. tho' I am of opinion with *Boerhaave as to his general hauleur, yet I must confess his Arguments in proof of it are by no means conclusive. The quality of the blood determined to the brain has been much insisted on as of considerable importance; but I think more might be urged from the quantity, a consiederably superior to the fluids in any other organ. This added to every appearance of a singular apparatus in the brain afford the strongest presumption of a secreted fluid; but those alone are insufficient for a proof, and had I not other Arguments for the distribution of a fluid along the nerves to the solids the inferences from the quantity & structure would be inconclusive. Considering then the brain as a gland the secretion cannot be supposed to be an aqueous watery fluid, consequently can contribute to no other than the purposes of nutrition, such a fluid being previously prepared

to

to be inadequate to the functions of sense & motion.
Dr Haller has assumed the supposition of a secretion
in the brain which he calls the nervous fluid, he at
the same time infers that it is employed in the func-
tions of sense & motion, hence that it cannot be
employed for nutrition.

I would allow that the subtile fluid which is the
instrument of sense & motion is not that of nutrition,
but he assumes that the vehicle of sense & motion is
a fluid secreted in the brain, a supposition that
is inconsistant with the nature of that fluid, for I
have shewn that it is a fluid incapable of local motion,
consequently inactive, & it is unconceivable that a subtile
& mobile matter could be drawn from our Mass of fluids by
any preparation whatever.

I now proceed to corroborate our opinion by further
arguments.

Boerhaave was not wide of observing that Nutrition
is performed in the smaller vessels in the ultimate
fibres of the body from which all others are formed. We
see nothing in the Animal solids but fibres in various
degrees of compositions, or cellular membrane. Nu-
trition must be performed by Applications to these &

to

to the Staminal fibres which lay the foundation for all after accretions; but here arises an Argument that the Nerves are the Staminal fibres of the body, hence the basis of the formation of the rest whether by Evolution or Epigenesis.

We know that in the first appearance of the Animal Embryo the parts that are discernible are the Brain & Medulla Spinalis, & these are distinct & appear sensible both before any other parts of the System are visible; these are the Staminal parts, & every other part we may presume must be more fully formed and evolved by previous steps of Nutrition in these.

This is illustrated from the consideration of the Body being nearly made up of cellular texture; if any other matters occur in the composition, they have originally been so, but the cellular texture is so similar in it's several parts, & so little diffuse in the compactness of it's parts in any period of life that it has been generally esteemed an inorganic Mass, & hence it is difficult to conceive that it should take on the particular size and form in an adult without some fundamental parts to determine the Arrangement and formation of the whole.

from every appearance the Cellular texture does not appear to have been a part primarily present in the Animal Embryo. The Cellular Membrane is often formed & retained after the body is grown up, and therefore appears to be one of the parts of the after formation which arise from Secretion. These brief strictures could never occur in the Staminal parts the fundamental constituent materials of the whole from which all others were extracted, arranged & delineated. The idea of a part fundamental to the whole being subject to destruction & reparation by parts formed from itself is inconsistent & contradictory, more especially as we adopt the doctrine of Evolution. It's quantity is confined to a certain degree which must be owing to a certain limited delineation of it's parts in the Stamina. It's quality too in density, laxity, porosity, &c. varies in different parts; this in the folds of the peritonæum this membrane is of a much firmer texture than under the cutis in the Arm or other parts, which could never have been so uniformly diversified except it's secretion had been influenced by the Staminal parts.

Haller & other Physiologists who are fond of deriving

the formation of our solids & fluids from the cellular texture must unavoidably admit of two suppositions respecting the fundamental parts of our system; whether they consist of simple fibres or of a set of vessels delineated in the animal. If the cellular texture is the primitive, and the basis of our system, its structure must be either fibrous or vascular; the supposition that it may arise from secretion on the surface of the vessels proves nothing, for the question will recur to the formation of the vessels which depend on the staminal fibres. The Arteries are composed of fibres differently arranged, in veins & other membranous parts they are red, & discernible, tho' their composition it is probable is the same with the Arteries, & their structure is naturally, tho' not visibly, fibrous. The negative demonstrations that a fibrous structure cannot be seen in the dura mater &c. cannot be admitted, for from Authors whose judgement is unbiassed we are assured of a fibrous appearance. The proofs that have been adduced to the contrary are entirely fallacious, & the negative refinement of their resolution by a continued maceration into a cellular substance is unfair & inadmissible. For

Mr

Mr Hewson has shewn that the Aorta itself is liable to a similar resolution, to which a fibrous structure can never be denied.

The existence of the Stamina fibres are not to be disputed tho' to us they are invisible, for in the progress of life they are covered & concealed by the accreted cellular texture; this is illustrated by the fibres of Bones wch gradually disappear in the advanced state of the Animal. Mr Cowper's Lecture shews that the formation of the Bones is known on a fibrous structure. In the long Bones the fibres are parallel, in the Cranium the fibres proceed rectilineally from a Nucleus as a centre every where to the circumference of the Bone. In the Interstices between the Arrangement of the fibres a matter is effused which hardens & totally obliterates the appearance of fibres. This likewise most probably occurs in the Membranes & the cellular texture, hence the presumption is strong that the Animal body is formed of a fibrous which is the Staminal Structure.

If our Solids are made up of a composition of fibres they must originally proceed from the Semen, as in the Embryo, we discover no parts to be under a fibrous Arrangement, but the Semen [illegible]

substance of the brain & consequently all the fibres of the body must derive their formation from these. The medullary substance of the brain is under a greater diversity of circumstances than other parts, & tho' the exquisite delicacy of it's texture renders it imperceptible to our grosser optics, yet it's structure is more fibrous than any other part of the system. The continuation of this substance in the nerves is certainly the same, both from the circumstances of the infinite subdivision it admits of & from the most evident distinct fibres in the system being the muscular. If these I have satisfactorily proved to be the continuations of the nerves they will lend considerably to support our general doctrine of the fibres originally proceeding from the nerves.

Another favourable circumstance in favours of our doctrine is, that the fibres in many parts of the system tho' originally derived from the nerves, yet from various contingencies to which they are exposed, lose the peculiar properties of the Medullary fibres, hence their sensibility

sibility & Irritability. The Tendons in the opinion of Anatomists are continuations of the Muscular fibres, but from the state of the Cellular texture are exposed to various degrees of pressure from the Interstices being filled up with the solids matter to render them more compacted, it is not at all improbable that their original properties under such diversifications should entirely disappear.

I believe with Dr. Haller that the Tendons are insensible & also with Albinus that they are continuations of the Muscular fibres, differing only in the fibres being more compacted & closely compressed. These together with the membranes & veins, originally Nervous become so changed in consequence of subsequent alterations as to be neither sensible nor irritable.

From this view that the stamina of our bodies are of a fibrous structure & these fibres are derived from the Nerves, a presumption arises that the Nervous System is the Terminal part of the Animal body, and that the delineated Organizations on which the other parts are formed, are previously

existent in this system, & therefore Nutrition must be performed in the ultimate solids of the body & hence by the Nerves. The only objection to this is that Elegant doctrine of the Heart being formed in the original stamina & that the growth of the body depends on the action of this organ, that the heart & it's system of Vessels by degrees open & evolve the delineated organization of the various parts furnishing new matter for growth as it's Evolution gradually takes place; but from this consideration I derive an Argument that Nutrition is performed by the Nerves, as the heart antecedent to it's formation, must have it's irritable & contractile fibres produced, and if the Muscular fibres in general are formed from the Nerves the heart can be no exception, & it's substance must equally proceed from the same Origin. These portions of the heart are plainly it's fundamental part, & must have existed previous to the action of the heart. A Nervous System must have preceded these as

Essential

essential to the formation some degree of growth or evolution must have occurred. The heart having its organization delineated in the nerveous system increasing by power gradually evolving it from thence must manifestly be supposed to be consequent to the latter in the formation, formed be merely in the first Rudiments of the Embryo in a state of vegetable existence like enlivened by the active power of the Nerves.

Dr Haller refers to an ingenious Author Mr Lionet who has applied himself to the consideration of the first beginnings of Animals, & it appears that in their first formation they are but in a vegetating state & nourished in a manner similar to vegetables. Dr Haller indeed is of opinion that some animals are entirely nourished by a process similar to the Veg. Nutrition, but for Mr Lionet's Examination find in any part of his works that he is in possession on this subject as the reference from Haller would incline one to imagine.

I shall add a further consideration - that the power employed principally employed in exciting germs to contribute to their growth is the power of Heat which operates by the action of the Nerveous system. Those formerly

formerly shown that in Animals recently dead when the circulating fluids have congulated, Heat will restore the Animal to life, & it operates by first exciting the action of the vessels before the fluids can be restored to their proper tenuity. This is an analogy that illustrates the first beginning of life, & shews that the body is preserved in a state of vascular system united to a state of fibrility by the operation of heat. But whatever is the conclusion this analogy may furnish us with, & however it may appear as a confirmation sufficient to influence our reasonings on the subject, yet a further illustration must be attempted, & if I can make it appear that other organized matters are dependant on a vascular system our analogy will then admit of a conclusion.

The only organized bodies we meet with in the three kingdoms of animals, vegetables, & fossils are simply & entirely composed of one system of organs, the nerves. Every view we can take of a vegetable leads us to this Idea, as the whole of their structure consists of fibres variously arranged, & a cellular texture. The fibres & cellular substance in vegetables are arranged and

in the same manner as in our Animal bodies. From the Medullary substance of Animals fibres are dispersed every where thro' out the system. In Trees in the same manner fibres are carried on but more rare & uniform in size. It is now proved that plants are also coloured fluids & the Circulation is carried on in single distinct fibres; if they separate it is only in consequence of a fissure by being separated but still into detached distinct fibres. In all the term fibre without entering into the question whether they are hollow tubes or vessels having a circulating fluid, or whether they are Solid fibres which I illustrate fluid as one thing in a list of Cloth. So this we will pass over attending, it is sufficient for us that these Objects are no where analagous to the Vascular system in Animals. They are not formed of large trunks ramifying to an imperceptible minuteness as in Arteries, on the contrary we find every where the appearance of fibres take simple & uniform thro' the whole progress till you arrive at the utmost extremity of the plant. If in any part we observe an appearance of vascular

cular distribution, as in the leaf where the vessels of the stalk appear ramified, we find them from more accurate inspection to be fasciculi of fibres analogous to nerves.

We have of late been able to inject the vessels of vegetables, by the transfusion of a coloured fluid & we have an opportunity of tracing the course of the injection, & we find it to run in distinct lines in as many distinct fibres, separate from one another without any appearance of ramification. The particular collections of matter or fluids carried on in these unramified fibres are poured into the cellular substance into the same parts where we find the like in Animals. Thus leaves when first formed are formed in a fibrous structure, & that such is the case in seminal plant first formed by the hand of the Creator. In the Bud or germe of plants we see the disposition of the leaves & fibres. These differ not in size, throughout the process of vegetation, only here they are more compressed together, not being as yet extended & unfolded by the cellular substance on the interposition of, which their future growth & formation depends. In cases of decay & putrefaction the same circumstance occur. The fruit is first formed by the seed & is consumed surrounding

surrounding it, & the after accretion is from the cellular texture interposed between the capsula & outer bark. — Fruits are chiefly filled up upon the seminal parts by a pulpy cellular texture as you may see in Du Hamel's Anatomy of a Pear.

A more remarkable proof occurs in another part of vegetation, in the growth of woody trunks, wch are formed by a succession of layers that accrete to the trunk from the bark. From this annually layers are separated, which when first thrown out from the parts are gelatinous, but by the accretion of the cellular texture adhere more & more to the wood till they are formed into the ligneous part. In order to ascertain this I have recourse to the following Experiment. I cut out a piece of bark from the tree & upon the bare wood lay a piece of tin foil pricking over it. The separated bark, in consequence of this an uni-on will take place with the parts previously uncovered, & in a number of years the tin will be covered over with the successive layers of wood so that it will appear to have been first placed in the very centre of the tree.

Ben

Our application of the doctrine of Nutrition will depend much on the state of the nerves we set out with, & will considerably differ as we adopt Dr Boerhaave's or Dr Hales's opinion. So far the general position of the former I am inclined to assent, & have accordingly been employed in proving the Nerves to be the Organs of Nutrition. If a fluid is secreted in the Brain how sumetrains only present themselves for wch this can be appropriated, these are the functions of sense & Motion, and Nutrition. I have mentioned my objections to the insufficiency of a secreted fluid for performing the more delicate offices of the former, for wch there is a fluid inherent in the Nerves of a subtile Elastic nature. The only function then for wch this fluid can be assigned is for Nutrition what Nutriment must be supplied to the ultimate solids in which the original Stamina of our body consist, to the Nerves being the Stamina parts it follows that Nutrition must be conveyed by the Nerves. it being highly reasonable to suppose that the consistent parts of the body are necessary to those offices to be evolved.

Parliament

Anatomists agree that the solids were originally in either of the forms of fibres or cellular texture. The fibrous must certainly have been first formed or the staminal part, because as we perceive its increase in the further progress of the body it would be difficult to conceive the formation of such a complete organization from the cellular texture. It is probable then that the fibrous is the staminal part that delineates the organization in the Embryo, hence the fibrous is the fundamental part & these are derived from the nervous system being either nerves as they exist or continuations of these in every part. There are fibres in every membrane & viscus of the system, wch difficulties that occur as to their being nervous are obviated by the consideration of their appearance being obliterated & the loss of their peculiar characteristics Irritability & sensibility. The opinion, in opposition to this, of the vessels being the original staminal & the fluids propelled by the motion of the heart produce the growth by the extension & evolution of the parts; this doctrine long is superceded by the previous existence

of

of the nerves to the heart from which the heart derives the formation & the irritability of its fibres, in consequence of which its motions are produced.

Many parts are irritable in the adult that are not so in the Embryo state. Haller who condescends on particular instances that the stomach is possessed of irritability never knew the intestines, & this must be in consequence of a certain growth and more complete evolution of the parts by the nervous fibres. This applies to the heart whose fibres are produced from the Nervous system, the latter must have been previously formed in order to give the formation to these fibres qualities of irritability so essential to its function. Hence is another observation produced by Haller that the Animal is always first in a vegetative state to this gives a strong confirmation that Heat is the power that excites the Animal germe to life but the cause of their subsequent increase. We have thus demonstration that this power does act chiefly on the Nervous system of Animals, and hence we may presume that the nerves are the fundamental

mental parts of the system from which all others proceed & are supported, therefore the Nerves are the organs of Nutrition.

From the consideration of Vegetables I said they were in structure analagous to the Nervous system of Animals, as their solid parts are evidently fibrous. These have the appearance of Cylindrical substances, longitudinally extended; they proceed to the utmost extremity of the plant, of an uniform size, without any appearance of Ramification or Anastomose— besides these there is a cellular texture con-stituting the chief bulk of the Vegetable. Of these the fibrous part is the Nervous, the other is the additional accretion of cellular texture. This is illustrated by the ordinary growth of leaves & fruits, & by the formation of wood from the bark of trees. If you examine a tree in Win-ter you will find the inside of the Bark to be smooth & polished in its surface, destitute of Sap & not sensibly connected with the trunk or ligneous part; but in Spring the interior surface becomes succulent & turgid with Juice, more easily

dissolvable

divisible into fibres, as is evident from the Ivy. Cordage which is made from the fibrous interior surface of the Bark. From the Bark a kind of Gelatinous matter is drawn out which acquires a firmer consistence & becomes a cellular texture this gradually adheres to the outer layer of the wood, hence the bark is ornamented with cavities and receptacles for the juices of the plant. Third division becomes gradually stronger, but is limited to a certain period. When the cellular texture becomes more detached from the farinose part the at last the connection of the bark to the farinous part hardly appears. Here then we have an appearance of a fundamental fibrous structure a Juice is exuded from the surface with such a determination to form a cellular texture, which afterwards acquires a firmer consistence & forms the farinous part of trees.

Our general doctrine of vegetables is now sufficiently confirmed, that the fibres are the Seminal parts which delineate the different Organizations that arise in other parts. The vegetable structure consists of fibres or of tissue analogous to fibres

but

* Mr Hamper has clearly demonstrated that veg.
Blood no Vascular System.

but without vascular communication or anastomoses from such fibres vegetables are formed, and this structure directs the after growth of the plant by the cellular substance being formed upon it.

The Analogy between Animals & Vegetables being so far pursued & the sameness of structure in each so clearly demonstrated we may venture to assert that their mode of nutrition is analagous particularly as vegetables are formed & supported by a cavity as vegetables are formed & supported by a cavity corresponding to the nervous structure exactly corresponding to the nervous System of Animals.

I have thus far defined the question whether the fibres of Animals & vegetables are hollow tubes or spheroidal fibres, the latter seems much the most probable as we have no evidence from Leeuwenhoek of any uniform cavity in the former. Neither could any particular advantage be derived from the fluids being confined in hollow canals, for the velocity with which fluids are carried in the minute canals as the fibres of vegetables or the nerves of Animals can never be attained by a force merely percussive.

If they are tubes they are of such acility as not to

to allow the admission of fluids by any impulsive motion, we must therefore enquire what other power is adequate to the transmission of the fluids. An Analogy presents itself that it is a power similar to the attraction of adhesion in capillary tubes corresponding to the conveyance of fluids along chyme substances, by this may be the mode of impulsion in the fibres of vegetables & nerves of Animals. But numerous objections occur to the Doctrine of capillary attraction, but in every point of view it is unsatisfactory but in applicable; other powers peculiar in their nature may be the means of conveying the fluids thro' the fibres, & hence may be adduced that this nervous, adherent to the substance of the nerves, the instrument of their motion.

To this there is a power Analogous in the case of Plants, by which we can readily trace forcing sensations from the vegetable to the nervous system, but arising from the nervous system to the vegetable. That Plants have a kind of such subtle, plainly appears from their irritability

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and contractility; they are possessed of these properties in a considerable degree & have peculiar contractile motions whose operations must be referred to a Muscular System. This is evident in the sensitive plants wch are affected by the slightest stimuli, & whose number are daily encreasing by the further discovery of Botanists; hence the analogy is easily transferred to the Animal kingdom & there is the greatest probability for supposing that the properties of each entirely depend on an inherent Elastic fluid.

Many Physiologists have rejected Sensibility to plants, but this they have mistaken for Irritability which may exist seperately & independent of the former. Many Experiments have been lately made on plants which infer a peculiar irritability & a capacity of being acted upon by various powers. The action of light has considerable effects on the Oeconomy of Vegetables, and we observe from the Application of the Electrical fluid that the sap in plants is considerably promoted, & from the quickness of growth that occurs in Vegetables from Electricity it is probable that the Ether in

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the Nerves being affected it operates by convey-
-ing the Juices of plants with more velocity &
forwarding their extension. From the whole then
our Analogy amounts to this that in plants there
is a Nervous System on wch their whole formation
& nutrition depends. In Animals a similar
structure occurs & the same means of function must
be inferred from the same means of property in both
& hence Animal nutrition is performed by the Nerves.
It is performed in consequence of every fibre of the
System being continued from the Nerves, that these
are the only organized parts, & whatever further
secretion takes place is derived from their cel-
-lular texture. Here we might proceed to examine
in what manner the growth of the plant is perform-
-ed & determined, but we must be cautious of in-
-dulging a curiosity that may be more amusing
than instructive; we are deficient in materials
to go upon & must limit our enquiries till further
Experiments are made.
As to the growth of Veg.ls we are apt to conceive
that the sap taken in the Juices is distributed from
to the other parts of the plant & that hence the growth
proceeds

[illegible] in which the heat is kept at the vegetating temperature here, if we take in a branch with the Green-house ——

should begin at the root & proceed gradually upwards; but we can excite vegetation in a particular part of the plant when none is going on in any other part.

A perennial deciduous plant will shew no tendency to sprout from the root in winter, but if it is brought into a green house of a proper temperature it may be brought to perfection. Botanical physiologists have attempted an explanation of this by saying that the sap is in motion & that the organization arises on the end of the vegetation. It may however be excited at the top of the plant when there is no appearance of communication between that & the root below. If we take a vine & set it in a pot of earth & place the pot in the outside of a green house (a) that part alone will be vegetating when the parts exposed to the atmosphere shall not at all be affected.

This Lesson may be greatly diversified by bringing a portion of the middle of the vine into the house while the top thro' a cavity is exposed to the air. In this case the middle part only vegetates while the top & lower part are in the winter state of

of Sap for. — If again we place the bent with the
the heads be exposed the branch that was before
inferior into the situation of the other parts, then
the head & intermediate parts shoots only vegetate
& the part that before flourished with her manner
affected.

From these Experiments it is evident that when the vegetation is carried on in the middle of the plant it cannot be supposed that the Sap was confined to the vegetating part, but that it passed thro' the lower part of the trunk, where no vegetation from its presence took place.

These facts are extremely curious & interesting whether we that not only the presence of Juice & Sap is necessary to vegetation but also the power of heat is effected by disposing the Sap to act in a particular manner, in a way that is difficult to explain.

That there is a peculiar operation of powers is evident from this Experiment, but how they operate I can by no means pretend to determine. Different however from this is Animal Secretion tho' in many particulars resembling, for in peculiar Animals there may be [illegible] of secreting

the heat to a greater degree where the part is growing, hence a greater determination is necessary for the particular secretion in each. Besides the presence of juice & the Animal heat parts there is a portion of heat necessary which operates only on the part to which it is applied. Animal bodies do not grow through their whole growth in this vegetable manner for the fibres of the Animal are not extended by the impulse of the fluids from the heart. The germ is at first actuated by heat while the heart with the blood & muscular system is formed the Animal is merely in a state of vegetation, but after this we evidently observe that circulation & sphere according to the extent of the hearts action &c. The circumstances necessary in the Animal system are that the fibres are extended by the force of the heart, the muscular system is united with every distant part &c. the heart has acquired a power of action, & the fluids are confined within their proper vessels the body is nearly in a vegetating state, but as soon as the blood is propelled by the heart circulation takes place &c.

in every part of the system & nutrition is carried on in the same proportion that the strength of the heart is encreased. The evolution depends on the original stamina and the bulk is encreased in those parts where the vessels are made originally in a larger proportion & are more fit & ready to be evolved. The vessels of the head, the Jugular veins & Carotid Arteries are the first that appear in the system, the blood is chiefly directed to the head & it's parts first to obtain their growth. The impetus of the blood at the same time that it is determined to the head is directed to the Umbilical Vessels, & this distribution is necessary in order to form the proper connection between the mother & the foetus. In this way we can trace the original evolution of Animals & accordingly as circumstances occur that render the vessels more lax & pliant, so in proportion to their size the fluids propelled by the heart be directed. Whilst the original stamina direct the first impetus the extension will give occasion to growth & extension

&c.

Rapidity will be given to the parts that are formed. The first growth produces the first resistance, & thus encreases the action of the heart in proportion to the resistance of the vessels, & the stamina will direct the growth & determination to others till the whole is completly sustained. In this way we can conceive the parts of Animal bodies to be formed in succession, the resistance encreasing in proportion to the extension & evolution in each. We see in a child just born where there is no further accession for the Umbilical chord the determination to this is suspended & the vessels composing it are stopped up while the fluids are directed to the extremities which previous to this were small in proportion to the rest of the System.

From this we may account for the cessation of growth in animals when the parts have acquired such a rigidity as to hinder the action of the heart; the most obvious instances of this occur in Bones which determine the growth of adult Animals. Consequently in the first stage we can discover the first rudiments or stamina of bones, these are

are at first of a tender gelatinous texture; from this state they gradually acquire firmness like they proceed to that of a soft membrane they harden and require an elasticity like they become hard & rigid & possess of every little flexibility; this is the process of every ossification in, first the parts are cartilage & transparent having no appearance of yellow as red blood, the bone acquires little consistence like the yellow vessels appear, when it is in its fibrile state as soon as the ossification begins the red vessels appear in the centre of the ossa but mostly this is peculiar to the broad bones for in the others the vascular appearance is not wholly confined to their centre, as in the broad bones. In the former the vessels from the beginning ossifications are extended in direct lines to the circumferences. In the latter they are extended radiolineally towards the extremities when they terminate in epiphysis.

Our first conclusion from these curious facts is the general confirmation of the idea we have given of evolution that it depends on the acceleration of parts

parts whence a certain force of circulation is necessary to the formation of Bones. As to the mode of its operation I can say little that is satisfactory, perhaps some power may prevail analogous to heat in the vegetable system, by which the fibrous fibres is put into a condition to form a cellular substance on the surface, & it is not only necessary that this should be formed on the Animal fibres, for the bones consist not wholly of a cellular texture that acquires hardness but of a Membrane in the cavities of which a matter is poured that hardens into Bone.

This matter is universally allowed to be of the same nature with the gelatinous substance that forms the rest of our Animal solids, but firmer in composition, & from this it would appear that a previous formation of vessels must take place in order to give the secretion to be poured into the cellular texture.

Du Hamel has traced the formation of Bone thro' the several states, he has examined the matter

matter effused into Cells & from this Experiment there is little doubt but that the formation of Bones & Cartilages are in this way accomplished. Dr Walker only attends to the particular secretion that is proper to harden into Bones, whilst he neglects the previous formation of the cellular texture intended as a receptacle for the osseous matter in every part of the system. There are Stamineae fibres continued from the Nerves which by an impulse of the blood are put in agitation to secrete a fluid which concretes into a cellular texture, by this the Muscles are detached, & Juice is secreted that is varied according to the nature of the adventitious cellular texture. There may be some difficulties attending this doctrine, but the advantage of what I have delivered is to be received as a fact, both from the Analogy of Vegetables as well as from what we know of the formation of Callus & the generation of new flesh in wounds & Ulcers.

The whole of our Doctrine on the subject of Nutrition amounts to this that the Stamina of Animal Bodies, and probably their natural basis & the fundamental parts of our Solids & Fluids

fluids. The nervous system is the terminal part of the whole & the nutritious matter must be conveyed by these because the increase of the system must be accomplished by the extension & evolution of these medullary fibres that are continuations of the nerves.

In these alone the organization is determined & delineated the subsequent accretion being entirely derived from the cellular texture. This is illustrated by the consideration of vegetables that as in these seed is the active power as in Animals that or some power analogous to it puts the nervous fibre in action to give growth to the cellular texture & to delineate the arrangement according to the quality of the stamina. In Animals it is the motion of the fluids propelled that distends & extends the parts. The Arterial system is distended by the power of the heart & this contributes much to the evolution of the parts. I gave a particular illustration of this in the formation of stones, where there is no considerable progress, no true gestation without the

Extension

dilatation of red vessels, & the growth of the Bone is always in proportion to the dilatation of these vessels. This may lead us to a supposition that the action of the heart gives growth to the cellular texture, but Bones are not composed of this Membrane, but of a matter deposited in its cavities for the secretion of such a suitable Apparatus is provided.

I proceed to give an illustration of this in the formation of Callus, the occasional repair of broken bones, or of any loss of substance that in these. On this subject 3 most eminent Physiologists have occurred among many controversies have occurred among Physiologists relative to the formation of Bones, respecting the nature of the membranes that by the secretion of the hardening matter become Osseous and what are the Stamina of Bones & bones that are to be the stamina of Bones & how these are dictated from the Periosteum, or whether the stamina of bones are to be considered as a membrane of which the Periosteum is a part, or for a shorter form of this question, whether the stamina of Bones are dictated from the Periosteum & ossification from the

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* The former of these is the Opinion of Dr Halley
(Borel. de Motu Anim. Phys. Lib. XXIX. Sect. IV. The Author of
Mr Duhamel.

to the Bones, or whether the Periosteum like the Inner Bark of trees forms successive Lamellæ of Bones?*

We shall determine this question the general fact appears to be that the Ossification proceeds by the successive Layers becoming Osseous - one or two immediate causes of this Lamellated structure in their Bones long before they acquire their full growth seems to admit of extension of the internal membranes. The internal layers then enlarged are gradually extended more distinct to carry on the succeeding Ossifications. What Duhamel delivers concerning the formation of Callus with Instances of Ossification &c. Bones on this subject many disputed have been agitated such as whether not minutely discuss. The Argument Duh.s inferior Callus is not an organic Commencement of Bone filled to harden, but it is an organized hard plex simulated Structure with a copious distribution of vessels even more vascular than the Bones, nor does the Ossification of Callus ever take place without an appearance of Callus.

We shall now consider the appearance of Callus

callus & it's progress according to Du hamel & Fougereaux, from the consideration of the progress of which & the distributions of the vessels you will be convinced that they are not derived according to Dr Haller from the Gluten of Bones, but from the Inner layer of the Periosteum— When a Bone is fractured an Viscous Juice is effused by the vessels between the extremities of the Bone which grows hard & forms a Callus this is Dr Hallers hypothesis, but a demonstration against it is that Callus is organized & vascularated as in natural bones; no Callus can be formed without red vessels penetrating as in preceding as in the original formation of the Bone, and it must be formed either from the internal or external Periosteum, & not from the latter from the last. My opinion therefore coincides with Du Hamels that it is formed of the inflamed layers of the Periosteum, by effusion of the Coagulating matter in vessels from the inflamed surfaces, wherein it is detained in cells and there ossifies. In a fracture he finds that the Periosteum thickens & inflames for the first three days & in a damaged, the thickening is made of the cellular

cellular substance into which a fluid is poured that coagulates into bone. Now in a bone that has arrived at its full growth, in consequence of a fracture the sensible parts are affected by inflammation from the abstraction of those vessels which again induces the growing state. This is analogous to the reparation of a loss of substance in other parts of our body. Further that in the inflammation of bones the inflammation first always begins in the cellular texture which were before more compact, whence the increased density as above obtains in the part.

It must be obvious from the formation of callus by the separation of successive layers that by this we should require an Idea of the Irritability of other parts by the propulsive forces of the Arterial System: in all other cases of renewal of substance the reparation is performed by the cellular texture. There is no new growth occurring without the formation of fluid to this accordingly in callus an inflammatory state; this gives a particular illustration of the formation of the cellular texture, the contractive force of the Arteries increased by inflammation determines the matter to give new growth to the cellular

texture

texture, this is evident from the great sensibility of growing flesh, from which we have a presumption of the influence of the nerves in nutrition, for the impetus of the blood in inflammation being greater than the resistance of our fibres gives extension otherwise that condition to the nerves which is necessary for their effecting the cellular texture. In the renovation of a part there is certainly a return of sensibility & irritability in some parts where they have been lost, thus the nervous staminal fibres may be so surrounded by the cellular membrane as to be incapable of the motion necessary for the purposes of sense, yet when united & restored they may be restored to their proper nervous state.

Some arguments have been employed in favour of the nerves, as the organs of nutrition; that when the nerves are obstructed the parts are deprived of nourishment & immediately shrink. Dr Fuller mentions the atrophy of paralytic limbs, & this he first adduces as an Argument in favour of our opinion but we would submit it but I would our opinion but we would submit it but I would by no means employ this as an argument for

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the bulk of parts depend little on the solids but on the quantity of fluids: and it is not probable that the solids are in this case diminished — the bulk of the fluids depend on the free progress of the circulation & when the action of the vessels is diminished the parts shrink: the solids in a healthy state may prevent the transmission of the fluids & hence the plumpness of the skin in such a one, & other parts may diseased, yet the solids be not at all diminished. Dr Haller objected to this hypothesis that the transmission was incompatible, for he says the stimulated fluid required for Nutrition could not pass the minute vessels while the incumbent with the motile fluid required for circulation. but this does not appear to be true, for the fluid may be of the greatest subtile kind be in a condition for extravasation or called matter. The Attraction for extravasation arises chiefly from the cellular texture with which it is connected, but in passing thro the minute pieces of the skin it is probably made extremely fluid & yet is in a condition to form solid matter. Pain can raise doubts as to this matter forming the skin or other coverings of parts, but must

must admit that it is circulated in the slender vessels of that System: the fluid in the system of vessels may be dilute & extremely fluid such by certain drinks powerfully corrected. Therefore if we see an Ox in the same kind be originally in the same state, the fluid is transmitted thro' vessels of the greatest variety from the mother; & yet, perhaps not in such a condition but that it is afterwards liable to corrode & form a new bones shell.

The other part of his Argument that the fluid is diverted from the proper nervous office is not to be admitted for the purposes of Nutrition, we may too readily admit, for the fluids employed in both these purposes are of a very different nature. A Palsy affirms that these two parts of the Animal Body that are destitute of Nerves cannot be nourished; but he will not be entitled to have that either these parts have not or never were supplied by Nerves & till this is rendered evident, his Arguments can not be admitted.

In Atrophy he observes that tense stiff tendons whereby the nervous fluid does not appear to be interrupted; here I would allege that tense

may

may often remain in the skin wch is an Organ of acquisite delicacy thas a remarkable proportion of nerves, hence while it remains sensible in some degrees the motion of muscles may be excited. Johnston that Paralytic affections do not produce a diminution of the part in consequence of the nutritious matter being withdrawn, for the bulk of the solide is very inconsiderable to that of the fluids, which depend on the action of the heart, on this depends the growth and gradual evolution of the system, and this extension is continually going on like the resistence of the fibres is overcome for the action of the Heart. As the parts encrease in size, so likewise do they encrease in density, for if the Hearts force increased in proportion to the bulk of the system, growth might always continue, but we know that this proportion is continually diminished, till a just equilibrium is formed. The muscular fibres acquire more density, tone, and contractility, and with these gratification has a great share; for by this process many vessels are entirely destroyed, and others rendered so rigid as to overballance the action of the heart, besides the increased rigidity of

of the vessels, the cellular texture is condensed by the increase of its solid matter, and by pressure lends to obliterate the vessels it surrounds. These then are frequently extended, so their force to resist the extending powers must be constantly increasing, and either the propelling powers must be increased in their momentum, or the effects be diminished till the resisting powers are in a balance with the propelling, and then all further augmentation must cease.

Besides the power of extension in increasing resistence, several others concur, as no pressure &c. and though it may be difficult to apply to every particular phaenomenon of Sublition, yet the general idea of the heart giving Extension must be allowed by all, and this joined to the doctrine of the original Stamina, explains the evolution of Bodies. We are certain then that the propelling power resides in the heart and larger vessels; we find the heart to be among the first of the System that first arrives at its full growth; it is also one of the first that stops, and does not increase in proportion to the rest of the System; the growth is always less as you proceed towards the Arms. The heart which

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in the Fetus was ½ of the bulk of the body, in an adult has a much greater disproportion. Independent of the question as to the diminution of the contractile power, the quantity of blood that is thrown out with respect to the internal System that contains it, is smaller and smaller, and hence we understand how the Animal body encreases more in given times from its first being evolved, and the after growth is a series of proportionals continually decreasing. The Evolution does not take place uniformly in different parts of the System, for some parts arrive at their determination sooner than others. This is explained by supposing that some vessels in the original Stamina are more free and turbulent than others; this however is rather inferred from effects than actually proved. The internal organs should on many accounts first arrive at their determined Size, and accordingly we observe that the vessels from the heart to the head are longer and have a freer circulation than those in any other part, the head then and its parts are first formed and first arrive at their Size. The lower extremities and those parts left forward in evolution are continually gaining upon the head. This will assist us in the explication of several

several Phenomena in Pathology. From the first beginning of Animals, and during the progress of their growth, the Arterial System is in a state of Hemorrhage, and the increased action of the heart will appear more considerable in proportion to the particular determination, hence if any disturbance is given to the circulation, the effects appear more especially in the head, and Hemorrhages of the Nose are more frequent in children, and before the age of Puberty than afterwards where congestions most commonly occur in the Abdominal Viscera.

If the Nerve when the propelling powers are in balance with the resistance, the proceeding growth of the body must depend on the increase of the quantity. If the bulk of the fluids increase, while dilatation does not take place in proportion then the Plethoric state will occur and shew its effects in those parts where a smaller capacity is observable, as in the Lungs. This is a separate part of the circulating System which must preserve a certain balance with the other parts, the quantity of blood passing thro' the Lungs is equal to that passing thro' the Aorta in a given time, consequently the transmission must be made with greater velocity,

and

and hence any change in the velocity of the blood will be more evident and apparent in the Lungs. This will more especially appear if the capacity of the Thorax is not enlarged in proportion, and hence a Plethora will have a greater effect upon the Lungs. From our doctrine we can easily understand how parts may be evolved according to the different proportion of the Stamina. The Genital organs are in both sexes fitted to be evolved at a certain period of life, about the Age when the Plethoric state is most observable, the original Stamina determine their Evolution at this period, and in consequence of this various irregularities are produced in other parts of the System. In the female sex where the Evolution is considerable, by the formation of a number of vessels, in those the determination to the Uterus as connected with the Sanguiferous System will have considerable effects at the time they are evolved. This portion of the System is so ordered that it should have a considerable influence in forming a balance between the Nervous and Sanguiferous Systems, hence we shall understand why so many disorders attend certain conditions of the Evolution in the Genitals. With regard to both sexes this is to be taken notice

of

of, that at a certain period there is an Evolution of a part of the Nervous System, to be endued with new powers, Sensations &c and with such circumstances as gives it a particular connection to the whole of the Nervous System – such considerations we are led to from the general Evolution of Germs.

The Evolution I am speaking of more especially consists in the dilatation & contraction of the Arterial System, which from the Muscular fibres it contains is subjected to the influence of the Nervous System.

Another balance occurs between the Arteries and Veins; for the purposes of growth we observed that a Plethoric state of the Arteries was necessary; the Arterial System cannot discharge as much into the Venous, in the time of a Systole, as it received from the Ventricle of the Heart, and hence an accumulation must ensue, which must depend on a set of vessels not easily admitting red blood, or on a resistance of the vessels immediately receiving it, if the Arteries terminated into vessels which admitted their contents with greater Ease, whether from laxity or size, the accumulation would be little or none, and therefore the retardation and growth of the System would not be carried on; hence na-

ture

Nature has provided a resistence to the Arteries by the Veins, which give a greater resistence to the Arteries in proportion as the animal is nearer its origin, and decreases till it comes to its Acme. Dr Whitenham has measured the capacity of the Veins, and finds the latter to be thicker than their corresponding Arteries — if this fact is received that they are a provision of nature for the extension of the Arterial System, for as long as the Veins exceed the Arteries, so in proportion are the latter more extended and filled, and by this continued extension their density is increased. At the period when all farther step is put to the increase of the System the balance becomes equal, and from hence it must be evident that this increased resistence must have an influence in determining the Acme; but from the very circumstances of dilation and impulse in the Arteries there is a tendency to increase their density and resistence, while no such causes are applied to the Veins, hence at a certain period an Aquilibrium must necessarily take place hence the observation that Arterial hemorrhages are more frequent in young people, in a more advanced life a Venous Plethora takes place

places, and if in these Hæmorrhages occur I would not assert them to be Arterial, but that they rather happen in the extremities of those vessels from the resistence in the veins; corresponding to this we observe that the diseases of youth are Hæmorrhagic and Inflammatory, those of old people the contrary, chiefly arise from venous congestion, to speak in the language of Physicians.

The reception of the Blood at the Veins in the various Secretories and Excretories, not before fully considered, contributes to balance the increased impetus of the Arteries, instead of that resistance it formerly met with in the veins; perhaps the blood in the whole System is increasing in order to promote this further evolution. Here then we perceive another balance between the Arterial and the Excretory System, but in what proportion this is maintained in different periods of life we are certainly ignorant. We must conclude from effects, and suppose that between these and the excretories certain proportions are established that so much does not pass off as is taken in by Aliment, and hence various fluids are accumulated than the necessities of the System require. When the Arteries

suffer

suffer no increase of capacity, and yet their contents are augmented, Nature has provided that the encreased quantity should be thrown out by the excretories; when this does not take place the bulk of the fluids is too great for the extension of their capacities, and a Plethora is generated. It appears to be a necessity of the System that as soon as the balance between the Arteries and Veins is established, a balance should take place in the Excretories that by these the superfluous ingesta should be thrown out. It is thrown out of the Sanguiferous System, in consequence of a secretion in other parts, and tho' not out of the body, yet the superfluities are every where accumulated in the cellular texture, and are excluded by a proportional excretion when these balances are completely established, which, in men, occurs about the 30th or 40th year, and then the period of Virility commences. In this however there is a variety, but in general this is nearly the time. What circumstances of the System determine this condition is out of our power to say.

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